CONTRIBUTION ON :

AIR QUALITY INDEXES

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Air Quality Indexes (AQI) have been developed since 1969, when they were used for the first time, in Toronto, Canada, to inform population about air quality. AQI have gained popularity since then, so many countries and regions use them in their Air Quality Management's Systems. Their main aim is to inform the non-specialist public about atmospheric pollution. In France, the ATMO index has existed since 1995. Its practical use was made official by a decree in March, 2000.

An international survey (assessment) among 47 countries or regions was conducted in 2000 in France by ADEME[1] and Ecole de Mines de Paris to hold information about AQI. The survey seeks to help designers of air-quality indexes by proposing a methodology for index's elaboration according to the desired objective of communication.

A total of 28 AQI[2] from 25 countries were analysed referring to their main goals, namely: communication, air quality assesment, decisions on high pollution events. Also, AQI were compared according to their mathematical construction; restitution method; local, regional or national appliance; communication period (hourly, daily); pollutants and time period integration included; use of qualitative categories and colours; accordance with other air quality management's tools (such as forecast, health effects, alert episodes, etc.).

Principal results of the survey are as follow:

AQI Goals

AQI are conceived and developed principally, to convey information to lay people in a simple and comprehensible way. Some AQI are constructed to assess air quality evolution in national or regional covering. Finally, few AQI are used to support decision's holders to apply special measures during high pollution's events.

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[1] ADEME: Agence de l'Environnement et de la Maîtrise de l'Energie (Environment and Energy Agency, France)

[2] Indexes exist in other countries, at least Russia and Malaysia, but no information about them could be obtained during the survey.

AQI Typology

In order to reduce a huge amount of information taken from several pollutants and measuring stations on a simple, significant number, a mathematical function is used. To compare different pollutants (and sometimes, different cities or regions), a single, non-dimensional number is given by the function for each pollutant. Six main functions were found on the survey. A complete analysis of these functions has been done, because important index's features, as the capability to convey some kind of information, are linked to the mathematical form of the function. Beside the function, the restitution method applied was analysed also. The restitution method allows authorities to summarise information from many stations in a single number. Three restitution methods were found (One restitution method produces one index for each measuring station, so, a set of numbers). An Air Quality Index typology was made, crossing the mathematical function and the restitution method. According to this typology, the 28 AQI were classified.

Methodological proposal to develop indexes.

A comprehensive analysis of the features of each type of index has been done. This analysis presents what kind of information may be generated and conveyed according to the type of index.

Accordingly, a methodological proposal to built indexes was developed. The methodological steps are as follow:

1. Define the index 's goal(s)
2. Define the index application covering (national, regional, local)
3. Define the desired criteria for the index (criteria are developed in the methodology)
4. Define the type of index, according to the mathematical function and the restitution method, and other features (pollutants included, communication period, etc.)
5. Pilot application and test with time series data
6. Index's Performance Assessment
7. Definitive Application

Example: the French air quality index in urban areas

The LAURE[3] of 30 December 1996 sets the preventive, monitoring, reduction or suppression of atmospheric pollution objectives and the goals for preserving air quality. Heading 1 - Article 4 of the law states in particular that the right to information on air quality and its impact on the environment is recognised as the right of every person on French territory. The decree of 10 January, 2000, about the air-quality index is derived from this determination to information for all, stated as an important element in the

[3] LAURE = (Loi sur l'Air et l'Utilisation Rationnelle de l'Énergie (Law on the air and the rational use of energy), Law 96-12 36 of 30 December, 1996 – *Journal Officiel* of 01/01/1997.

policy for air-quality management. This decree provides definitions of the ATMO index with "standards 2000" and the recommendations required for its calculation.

Previously (1992 and before), certain local agencies had developed their own index. Naturally these indices showed sizeable differences. The effort provided by the Ministry of the Environment, ADEME and the monitoring agencies, enabled the definition of a single index for the whole of the large urban areas (>100,000 inhabitants). The index gives a common language to the non-specialist public, which can now understand the overall air quality in different urban areas.

As all aggregate indicators of the same kind, the ATMO index is designed as a tool that makes it possible to translate in a quantitative and simple way the synthesis of numerous measurement data recorded daily by official air-quality monitoring agencies (AASQA).

The ATMO index is defined as a whole number between 1 and 10. It is calculated for one day and one geographical area defined by the official agency for monitoring air quality. In any case the index is defined as the largest of the four sub-indices calculated for sulphur dioxide, nitrogen dioxide, ozone and particulate matter (PM_{10}). The index is calculated for a day. Midnight UT is the departure time. For circulation the same day, the agencies calculate an estimate of the index at 4 p.m. local time To calculate the index there must be at least two urban variety[4] analysers for pollutants NO_2, SO_2 and particulate matter, located in an urban area. For ozone a minimum of one analysers in the urban area and one in the suburban area is required. The monitoring agency selects fixed stations so that the average of measurements made by these stations be representative of urban concentrations.

TABLE 1
Index levels, categories and colours. ATMO Index, France, 2000

			Particles	SO2	NO2	O3
Index level	Categories	Colours *	Daily mean's average	Hourly peak's average		
1	Very good	Green	0 – 9	0 – 39	0 – 29	0 – 29
2	Very good	Green	10 – 19	40 – 79	30 – 54	30 – 54
3	Good	Green	20 – 29	80 – 119	55 – 84	55 – 79
4	Good	Green	30 – 39	120 – 159	85 – 109	80 –104
5	Medium	Orange	40 – 49	160 – 199	110 – 134	105 –129
6	Mediocre	Orange	50 – 64	200 – 249	135 – 164	130 –149
7	Mediocre	Orange	65 – 79	250 – 299	165 – 199	150 –179
8	Bad	Red	80 – 99	300 – 399	200 – 274	180 – 249
9	Bad	Red	100 – 124	400 – 599	275 – 399	250 –359
10	Very bad	Red	125 +	600 +	400 +	360 +

All the concentrations in µg/m3
* These colours are the ones given on a national basis by ADEME. On a local level, some agencies increase the number of colours.

[4] The terms "urban" and "suburban" are defined precisely in the reference document: *"Classification et critères d'implantation des stations de surveillance de la qualité de l'air"* (The classification and criteria for installing air-quality monitoring stations), MATE, ADEME, 1999.

To summarise, the management of air quality in France operates in a decentralised framework. The ATMO index in this framework represents a considerable co-ordination effort between all the players participating in this system. The index makes it possible to compare cities on a homogeneous basis. This successful dialogue makes the index geographically coherent throughout France and constitutes a solid reference framework for the public.

You can visualise all ATMO indexes every day on http://www.ademe.fr/jda/indice.htm

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