EEA air quality web dissemination solution

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Recommendations for further development

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This ETC/ACC Technical Paper has not been subjected to European Environment Agency (EEA) member country review. It does not represent the formal views of the EEA.

Preface

The current report is a deliverable in the ETC project of 2006, task 5.3.2.2 “Presentation and Dissemination of air quality data in the Neighbourhood project”, and subtask 1: User review work - Recommendation report.

The input for this report is mainly:

- Meeting and discussions with EEA staff and EEA hired consultants during the finalisation period of the first edition of the ozone web spring 2006
- Expert workshop held in Copenhagen 8-9 March 2006
- Visit and discussion with AIRPARIF 12 April 2006
- Review of the final ozone web
- Review of several national solutions
- Analysis of lessons learned and experiences from NETCEN being responsible for the British solution, AIRPARIF for the Paris solution and NILU for the Norwegian solution
- Analysis of the results from the APNEE and APNEE-TU research projects
- General experience from the authors in developing and running web dissemination solutions for several countries.

It should be noted that we cannot guarantee that we have gotten the full overview of existing solutions in Europe. Furthermore the short descriptions and evaluations of the AIRPARIF, British, and Norwegian solution are made by the authors and may not do these excellent solutions full justice. Our purpose has been to look for common features in development trends in order to identify some lessons of value for the further development of the EEA AQ web.

We would like to thank Tim Haigh at EEA for inviting us to make this report, and all valuable and interesting discussions with him in this process. The EEA ozone web is an excellent starting point for a full EEA AQ web.

We also thank Karine Leger at AIRPARIF and Paul Willis NETCEN for valuable discussions. Furthermore we thank Nicolas Moussiopoulos, Jaroslav Fiala and Wim Mol for their contributions at the expert workshop in March 2006.

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Synthesis

The main purpose of this report is, based on the first edition of the ozone web, to advise on further development of this solution in relation to trends in air quality information dissemination solutions in Europe. This has been done on the basis of expected developments of the various national solutions across Europe.

The report is divided in two parts, in addition to an introduction chapter. Part one is the analytical part, describing the status of relevant aspects of air quality information dissemination in Europe. In addition, the development of asthma in Europe is described, asthmatics being important end-users of local air quality information services. Part two covers concrete recommendations for further development of the EEA air quality web. This part gives recommendations based on a combination of the authors' scientific, policy and management experiences.

The report recommends that EEA should expand the ozone-web by:

- including new compounds
- including forward forecasting functions
- developing multi language solutions
- developing a compliance module
- extending the GIS solution
- extending comparison solutions

Furthermore the report recommends that EEA:

- develops solutions to help countries with no or poor national solutions
- develops expert pages with:
    - QA/QC module for data providers
    - international reporting module for data providers
    - data export module for data providers
- develops the extended solutions in close consultation process with key players
- runs the new solution in close contact and with the aid of national resource persons

The report gives practical and hands on recommendations to EEA. It is a sincere wish that this report contributes positively to the further development of the EEA air quality dissemination solution, independent of whether the recommendations given in this report are followed or not.

1. Introduction

Air is an element of our life and a carrier of pollutants resulting from human and natural activities. For this reason, air pollution has been around as long as man has walked the earth, and this needs to be taken into account when discussing management and information services for air quality. In the heart of air quality (AQ) information services, methods, practices and tool design, the concept of perception and understanding are of profound importance. While the scientific part of the AQ problem has been, and will be further investigated in the years to come, little effort has been made to understand the way that citizens and decision makers understand and interpret AQ problems, and to the way that they link them to various urban related activities.

In order to investigate the way that atmospheric quality is conceived by man, and is associated to his activities, it is interesting to follow the historical footprints of atmospheric degradation and of its association to human activities. According to related literature (Karatzas, 2002), in the earliest extant from dawn of civilization, emissions from forging operations for bronze, iron, and other implements were well known (Genesis, chapter 4) and the emissions from smoking fires and blazing torches were already reported (Genesis, chapter 15), providing the first linkage between the concept of pollution and combustion-depended production activities. Such activities became the major polluter following the industrial revolution of the 19th century.

In parallel, it was early recognized that such anthropogenic activities may have a negative impact on human life, thus making Solon, the great lawmaker of the ancient Greece, to rule in favour of the relocation of “industrial activities” away from inhabited areas in order to avoid air and noise pollution caused by iron smelters (6th century B.C.). The link between urbanisation and environmental problems was established later in the ancient times: Vitruvius (75-26 B.C.) described city climates and climatic conditions in the Roman cities, to which an allusion on smoke pollution also appears in the poems of Horace (85-68 B.C.), while Seneca comments on the “bad air” over the capital of the Roman Empire (61 A.D.), complaining about air pollution as if he was a citizen of a contemporary European capital. Later on, and in the 12th century, Maimonides of Egypt documented the effects of polluted air on child mortality (in the city of Cairo, Egypt), a notion that was verified in the 20th century via various scientific research results.

The first known “attempt” to manage air quality at that time was made in England by King Edward I, who tried to clear the smoky sky over London in 1272 by improving the quality of fossil fuel, thus banning the use of sea coal. For the same geographical region, another contemporary aspect of air pollution that underlines the importance of AQ information provision was detected: smoke coming from open burning of biomass was transferred above the English Channel towards France, thus causing the French vineyard owners to strongly complain about the reduction in their production in the 15th century (transboundary air pollution, now part of the contemporary puzzle of atmospheric science and decision making).

All these examples demonstrate the fact that basic aspects of air pollution and air polluters were identified some centuries ago, while contemporary air pollution problems, effects and managing legal incentives have already been adopted by various societies long before contemporary life. Yet, the question of perception and interpretation of AQ remains open, and needs to be addressed in an effective way, in order to design better pollution abatement strategies and AQ information services.

1.1. People's perception and awareness of air quality

Although there are not many published papers on the subject, there are enough for drawing a basic sketch concerning what people believe/have in mind about air pollution and related notions.

According to Bickerstaff and Walker (2003), studies of human response to air pollution first emerged during the 1950s in the USA, where social survey techniques were used. Environmental concerns were expressed for a national level, yet people failed to realise that pollution may be a serious threat to their local community (Murch, 1971). Public opinion surveys were carried out by the State of California Department of Public Health in the late 1950s and measured psychological dimensions of air pollution. In the UK, early work on the perception of air pollution focused on the operation of Smoke Control Areas under the Clean Air Act of 1956.

In a paper of Skamp et al. (2004) on students' ideas and attitudes about air pollution, the authors provided a review of similar work and presented their own research results for Australia, for students from ages 6-20 years old. It is interesting to note that according to this study, the majority of students believe that air pollution is natural, and is attributed to animals. The majority of students identified the negative effects of air pollution for the environment and human health, asthma being the disease directly associated with the problem. Another interesting finding was related to what could be done for improving air pollution, where the majority of students required more education and suggested personal action (environmental friendly behaviour). Thus, the issue of providing AQ information designed to trigger environmental friendly behaviour, while educating the recipient on the subject, is emerging as important.

In another study, Elliott et al. (1999), reported that an important parameter on human perception of air pollution is the role of sensate factors as primary predictors of concern, i.e., experience with black soot, bother by air-pollution-related odours, and reported impacts on health and daily life, bringing to the surface the issue of personal experience. Nevertheless, according to Bickerstaff and Walker (2004) (and references therein), recent qualitative studies show a very low level of awareness and use of air quality information services - in particular those provided by central government. These studies have also revealed a consistent, if muted, scepticism of the motivations of government (or industry) in interpreting and presenting air quality data. When it comes to the relationship between information provided and public understanding, it is mentioned that "… the net result is that the information provided bears little relationship to most people's encounters with, or cultural understanding of, air pollution, and in consequence is either dismissed as an irrelevance or at worst taken as (further) evidence of disingenuous government motivations in the provision of information. The failure of recent changes in the format of air quality information …. to resolve these barriers to use, provides strong evidence of more deep-rooted problems in the communication process, relating to the construction of air pollution problems and assumptions about human behaviour embedded within scientific and policy communities".

A key issue is the understanding that perceived air quality and actual pollution (the latter based on measurements) are not always associated, underlining an information gap (of both temporal and spatial nature), concerning air pollution levels and air quality perception. Brody et al. (2004) report that while there are research results indicating no correlation between perception and high air pollution levels, there are others demonstrating that awareness of air pollution is scientifically correlated with actual measurements, and that there is a distance decay of concern spreading onward from urban centres towards rural areas. They also report on the linkage between geographic locations and forming perceptions of air quality, yet, such perceptions are also influenced by social, cultural and behavioural parameters. The work of Brody et al. (2004), for the Texas area

also suggests that the role of media providing AQ information is of paramount importance for the way that citizens understand air quality and respond to governmental policies that seek to improve local and regional air quality conditions. As they put it "... in this respect, more accessible and far-reaching communication channels should be established to provide the broader public with the best available information on air quality conditions". To this end, the conclusion reached by Higgs (2005) for the dissemination of environment related information concerning siting of waste facilities may be of use: "participative approaches that use IT-based methods, based on combined geographical information systems (GIS) and multi-criteria evaluation techniques that could involve the public in the decision-making process, have the potential to build consensus and reduce disputes". Moreover, Lindley and Crabbe (2004), suggest that IT tools, especially GIS based, should be used for the spatial representation of AQ related information, while also additional visualization methods, including 3D, should be applied, thus verifying the findings reported by Karatzas et al. (2005), concerning the APNEE-TU project. In addition, there is evidence that people have a tendency to prefer environmental information on local issues (Alabaster and Hawthorne, 1999), bringing up the issue of geo-referenced AQ information.

When it comes to the sociological dimension of the problem, Rydin (1998) notes that the language of air quality policy has traditionally not been placed in the context of moral responsibility to reduce harm to others, but in the context of individual responsibility for self-protection. Petts (2005) also states that "Altruism gains importance in the context of equity arguments that those most affected by poor air quality are those least able to make a difference and the least contributors, to the problem", and poses an interesting question that we should have in mind when designing air quality information services. "Is it likely that information stressing the individual and social benefits of action will support choice and responsibility or is some further institutional incentivisation required?"

Petts also mentions that "numerous studies confirm that the public is worried about air pollution. Negative perceptions are shaped by proximity to industry, measurements, and personal experiences. However, there is little evidence of beliefs in strong causal links between diseases and air pollution; rather there is an understanding that chronic illnesses, such as allergies, asthma, and bronchitis, can be affected by air pollution". This finding suggests that AQ information should certainly address those suffering from respiratory diseases, yet it should also underline the consequences of long-term exposure to high concentration values.

In the context of urban air pollution, it is argued that there is no benefit to the individual in taking action through the choice of a less polluting but more inconvenient form of transport, other than the potential satisfaction of altruism (Rydin, 1998). On the other hand, local authorities may also support the opinion that from information supplied, the public can make informed decisions about their lifestyle and how they effect the environment (Jenkins, 2006).

1.2. Providing air quality information services

There is a variety of air quality information providing/disseminating paths, all being directly connected to the operation of "traditional" and electronic communication schemes. Maybe the best and more complete example of air quality information services and their content can be found in the results of the APNEE and APNEE-TU projects (www.apnee.org). APNEE established a multi-channel information service platform for the dissemination of air quality information (and in this way provided a platform for the implementation of e-government information services). The dissemination platform made use of various telecommunication channels for pull and push service provision, including internet for e-mail notification, world wide web for detailed pollution related information,

SMS for early warning services, WAP and J2ME applications in mobiles and PDAs for enhanced graphical and informative content on the move, street panels (VMS) for covering key parts of the urban web and voice services for personal communication support. Moreover, APNEE provided location based services, and supported personalisation of the information channel(s), content, and frequency of information services and related alerts. The APNEE and APNEE-TU projects have provided material for a number of publications, some of them being available from the project web site (Johansen et al., 2001; Bøhler et al., 2002; Karatzas et al., 2004; Peinel and Rose, 2004; Karatzas et al., 2005). Apart form APNEE, some papers suggest preferred sources and content concerning air quality information services (Beaumont et al., 1999). In addition, some other projects like MultiMeteo, dated from 1998, and Marquis (2005-06) include in their approach the concept of automatic multilingual text generation for the support of environmental information services. Moreover, a number of projects and R&D initiatives have been investigating and developing air quality information services (Westbomke et al., 2004; Karatzas et al., 2004; Arauco and Sommaruga, 2004; Dickinger et al., 2005; Storch, 2005; MINNE; Luftkvalitet; YourAir; CITEAIR, AIRALERT). See chapter 5 for more details on European research.

1.3. Air quality information service characteristics

According to the findings of a study conducted in the frame of the AIRNET project, "stakeholders prefer information to be presented in short overviews using non-specialist language". In addition, a recently published survey on real time AQ information for asthma patients (Bush et al., 2006), showed that the respondents would like to be informed about a wide range of information related to monitoring and self-management of asthma. Avoidance measures and prevention was the first choice, followed closely by information on substances, and the environment and allergies. On the basis of this statement, and following the results reported in the previous chapter concerning the APNEE/APNEE-TU projects, additional projects and papers on air quality information services, the following basic service characteristics are drawn:

- Citizens prefer information that they can associate to the environment they live in (location, i.e. GIS service and interpolation techniques are of importance), their health status (information should address special citizen groups), and their way of life (personalisation on the basis of behaviour).
- Information should be provided in a simple, understandable way, preferably with the aid of an index (colour, graphical representation, etc)
- Information should be provided on an event basis, when and where the user wishes and requires it (personalisation on the basis of time and place, pull and push communication channels)
- Information should focus on
    - health impacts and ways to avoid them
    - current air quality status (measurements)
    - AQ forecasts (modelling tools)
    - Polluters
- Information should be provided on the basis of a holistic dissemination strategy concerning content an media used
- Similar textual and graphical messages should be used for all locations (and preferably countries), to convey the same amount and "meaning" of information. An index is useful, if it is easy to follow.

As already expressed by Dewdney (1998) "the urban surface is a continuous screen, or a series of overlapping screens, onto which representations are projected." Karatzas (2003) already suggested that urban air quality management and information systems may support decision makers towards environmental management for a sustainable society, and may also "trigger" the creation of new, user-friendly, human-centric environmental

information services that advance the improvement of the general quality of life in the city. These services, when applied on an operational basis, can help in the formulation of a new, citizen level perception on the environmental semantics of their urban environment and on the influence of their behaviour to the sustainability of their everyday living. Perceived residential quality was found to depend on physical neighbourhood attributes, such as noise and air pollution, on psycho-social characteristics, like safety or crowding, and on the availability and quality of neighbourhood facilities (Van Poll, 1997). The introduction of human-centric, environmental information services is thus expected to add a positive semantic (in equivalence to physical) attribute to the urban environment, as it will increase people's feeling for access to services, facilities and amenities, that plays an important role in the perception of quality of life (Sénécal, 2002). Air quality may play a leading role in becoming the pilot for flexible, adaptable, quality of life electronic information services, incorporating the recent advances in the research results of atmospheric sciences and health-risk assessment, the forthcoming developments of spatial services included in the INSPIRE directive, and the mandates of EU for e-government and e-participation.

Part 1 Status analysis

The status analysis of air quality information dissemination solutions in Europe should be the subject of an independent scientific study in itself, due to its potential size and complexity. We have here concentrated on relevant general aspects, development of asthma in Europe and some specific analysis of relevant solutions and trends in the developing of such solutions as a background for the recommendations given in part 2.

2. Asthma development in Europe

Asthma is presently the most common chronic disease during childhood, and it is in most European countries the most common cause of admission to hospital in children, in many countries up to 20% of admissions to paediatric departments (Jonasson et al., 2000; Wennergren et al., 1996; 1996; Malmstrom et al. 2000).

The lifetime prevalence of asthma in children has been observed to increase in Europe as well as in other parts of the world over the last fifty years (1998). From Norway several epidemiological studies have been published over the last fifty years, demonstrating this development. In 1948 Claussen published a report from 85 Norwegian medical districts, reporting a life time prevalence of asthma in school children of 0.4% (Claussen 1948). Eilertsen reported from Bergen from a study on school children a prevalence of 1.7% (Eilertsen 1954). In the mid seventies the asthma prevalence in Norwegian school children was reported to be 2.5% (Robberstad 1978), In the early 80ties, 3.2% (Skarpaas and Gulsvik 1985), but then suddenly ten years later a marked increase was reported in two different studies employing identical questionnaires (Skjønsberg et al. 1995;Nystad et al. 1997). Several studies performed 1992-1995 in different parts of Norway reported asthma prevalence of 10-12% (Steen-Johnsen et al. 1995;Nja et al. 2000;Dotterud et al. 1994). Then 10 years later from a birth cohort study the life time asthma prevalence among ten year old children in Oslo was reported to be 20.2% whereas as current asthma was reported in 11.1 % (Lodrup Carlsen et al. 2006).

A similar increase in asthma prevalence in school children was also reported from Denmark over the same years (Thomsen et al. 2004). In England a similar increase in the prevalence of wheeze of 70 % was reported from 1974 to 1986 in 11,262 and 9266 16 year old children born in one week of 1958 and 1970 (Lewis et al. 1996).

2.1. European increase in prevalence

A world wide study reported the asthma prevalence in children, 6-7 years old and 13-14 years old and showed the prevalence to vary throughout the world (1998). By looking at the European countries in this worldwide study a marked pattern of increase was found from the most eastern countries in European and towards the west. The prevalence of wheeze in the last 12 months ranged from 2.1-32.2% in the older age group and 4.1-32.1% in the younger age group and was particularly high in English speaking countries and Latin America (1998).

This large scale cross sectional study was repeated seven years later in 2002 -2003 including 193,404 children aged 6-7 years from 66 centres in 37 countries, and 304,679 children aged 13-14 years from 106 centres in 56 countries (Asher et al. 2006). Most centres showed a change in prevalence of 1 or more standard error, with increases being twice as common as decreases, and increases being more common in the 6-7 year age group than in the 13-14 year age group. The pattern of increase in asthma prevalence from countries in Eastern Europe to the West was broken. Over the seven years between the two studies a marked increase had occurred in countries like Poland, Russia, Estonia, Latvia, Ukraine and Rumania, levelling out the differences. A levelling out of the increase was noted in some countries with the highest reported prevalence during the first study, such as United Kingdom (Asher et al. 2006).

This levelling out of asthma prevalence has been noted in some European countries but with no decrease in prevalence. In Switzerland no further increase in asthma prevalence was recently reported (Braun-Fahrlander et al. 2004). From England a levelling out and

decline has been reported in asthma consultations in general practice (Sunderland and Fleming 2004). However, this finding could not be confirmed by Burr et al who reported from three studies in 12 year old children in Wales in 1973, 1988 and 2003 with an increase in asthma ever from 5.5% in 1973 to 12.0% in 1988 and 27.3% in 2003 (Burr et al. 2006).

Also in adults increases in asthma prevalence have been noted. Brøgger reported this from a study in Bergen (Brøgger et al. 2003). From studies performed in 15 industrialised countries Sunyer et al reported a 2.4 times increased risk to suffer from asthma in adults born in 1966 to 1971 as compared to being born in 1946 to 1950 (Sunyer et al. 1999).

2.2. Reasons for asthma increase

What can be the reasons for this dramatic increase in the prevalence of asthma? Many causes have been suggested, but no definite answers can be given.

One of the most discussed hypothesis is the hygiene hypothesis, launched by David Strachan more than 15 years ago (Strachan 1989). He suggested that atopic disease was related to household size and number of siblings. According to this hypothesis more infections in early childhood protects against development of atopic disease, including asthma and hay fever. This hypothesis was later supported by immunological data (Holt 1995), although during the last years this possible hypothesis has been much more discussed, as the distinction between T helper cells of type 1 and 2 (Th1 and Th2) is not as distinct as previously believed, and that genetic studies have shown the interrelationship to be much more complex (Ober and Hoffjan 2006;Munthe-Kaas et al. 2004).

The causes of increased asthma prevalence are probably multifactorial (Lodrup Carlsen et al. 1999). Among known factors maternal smoking during pregnancy and second hand smoke in early life should be mentioned. Smoking in pregnancy has been shown to cause reduced lung function at birth (Lodrup Carlsen et al. 1997;Hoo et al. 1998), and later in childhood a relationship between second hand smoke and later asthma has been shown (Strachan and Cook 1998). A relationship to respiratory infections like Respiratory syncytial virus infections early in life have been demonstrated (Sigurs et al. 1995;Sigurs et al. 2000;Sigurs et al. 2005). Furthermore the indoor climate with damp houses may contribute (Bornehag et al. 2001). A focus has been put upon modern life style factors as a relationship has been found among asthma developing during school age and increased body mass index and obesity (Castro-Rodriguez et al. 2001). Furthermore a lack of physical activity may contribute as low physical fitness has been related to later development of asthma (Rasmussen et al. 2000), and a relationship between low grade physical activity, high body mass index and single gene polymorphisms for genes regulating the $ß_2$-receptor has been reported (Barr et al. 2001).

Also outdoor environmental pollution and traffic-related air pollution has been discussed as a possible cause. In an English study socio-economic deprivation was found to predict for admission to hospital of both older persons and of school children with asthma, but after correcting for these a background urban NO_2 levels in the ward of residence was found to be significantly associated with standardised hospital admission rates for all respiratory disease in children under 5 years of age. The authors speculated if this was due to a causal effect of NO_2 on the respiratory health of children (Walters et al. 1995). Also other reports have indicated a relationship between respiratory symptoms and road traffic (Livingstone et al. 1996;Oosterlee et al. 1996). In Switzerland incidence and duration of respiratory symptom episodes have been reported to be associated with particulate concentrations and duration with NO_2 (Braun-Fahrlander et al. 1992;Braun-Fahrlander et al. 1997). Using a geographical information system based modelling a

relationship was reported between traffic related air pollution and cough in children below two years of age (Gehring et al. 2002), and Gilliland and co-workers reported a relationship between ambient pollution, especially ozone, and school absenteeism in children (Gilliland et al. 2001).

2.3. Economic costs

Asthma is a burden in several ways, economically for the community in terms of direct costs (drugs, medical consultations, hospital admissions) (Weiss and Sullivan 1993;Weiss and Sullivan 1994) and not the least indirectly (absence from work of parents and adult patients, absence from school of children)(Weiss and Sullivan 1994). Furthermore, asthma is a burden for the individual child with asthma, as well for the family in frequent doctor's consultations, sleepless nights and reductions in social and physical activity (Lenney et al. 1994).

The total European costs of asthma has been calculated to € 17.7 billions per year; 3.8 billions for out-patient care, € 3.6 billions for drug treatment; € 0.5 billions for hospital in-patient treatment; € 9.8 billions for absence from work (2003). With proper management including environmental control much can be saved both in costs as well as in sufferings.

2.4. Asthma and information dissemination solutions

People with asthma have shown a great interest in several countries to the more advanced information dissemination solutions ((Karatzas et al., 2005, Marsteen et al., 2004). Not surprisingly, since it is general well accepted that bad air quality worsens asthma conditions (Løvik M, 2007). In many countries in Europe up to 20% of children have been diagnosed with prevalence for asthma as earlier discussed in this chapter. For each child there is often an information interest from several adults. In addition come all the adults with asthma. The potential number of end-users for good designed air quality information services is therefore very high and increasing in many European countries.

3. Legal Framework of AQ Information Dissemination

Environmental regulatory agencies are mandated to protect the environment. City authorities and legal government agencies, through functions such as planning, monitoring, licensing and control bodies, generate and accumulate a large amount of environmental information (measurements, historical data, topography, legislation compilation, environmental terms and limits). At the same time this represents a growing need for access to additional and complementary information to support their functions (such as studies and results for decision making and policy establishment, tools for environmental quality monitoring and channels for gauging citizens reports and demands).

While the available environmental information increases rapidly, appropriate Environmental Information Systems (EIS) are needed that will aid city authorities and administrative agencies to develop and structure their capacities in accessing and managing environmental information, especially in electronic forms. Moreover, the mere existence of technology to increase public accessibility to environmental information has increased demand for information collected by state bureaucracies. With respect to the needs and functions of the cities, such EIS should be able to: a) exploit the accumulated information available at the public sector and bring it in easy-to–use and accessible forms, and b) create platforms for information input by the other community stakeholders and provide access to expert knowledge and advice.

EIS are usually found in the public sector. This imposes budget constraints that influence data collection, information sharing and the ability to hire and maintain highly qualified personnel. This problem is aggravated by the multi-disciplinary nature of environmental problem solving. The range of skills that are required for operating EIS encompasses computing, statistics, cartography and knowledge from the appropriate domain disciplines (Haklay, 2001).

3.1. Legal framework regarding air quality information dissemination

Access to environmental information is discussed in detail in various papers and reports (Resources for the Future, 2001, P.H. Sand, 2004). The first EU legislation regarding air quality information exchange and availability was Dir. 82/459, which was replaced by Decision 97/101 that established a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States (article 1). Moreover, in the same directive it is stated that this information will be accessible to the public via an information system set up by the European Environment Agency and that it may also be supplied by the Agency or by the Member States upon request (articles 4 and 5). In order to support this important issue, the EEA has established the European air quality information system Airbase. Airbase contains information on air quality monitoring networks and stations and on air quality data for a selection of stations and a number of components. The aim is to combine the two “old” EU databases, APIS (Air Pollution Information System; air quality data) and GIRAFE (meta-information on air quality networks and stations). With the aid of Airbase, air quality data and related statistics are accessible via the web to all individuals interested.

The Council Directive on Ambient Air Quality Assessment and Management (96/62/EC) requires that action plans be developed for zones within which concentrations of pollutants in ambient air exceed limit values. These limit values are established by Daughter Directives. It is worth noting that in these Daughter Directives, the use of

computer-network services is mentioned in order to provide the public with the appropriate air quality information. Up-to-date information on ambient concentrations of air pollutants should be routinely made available to the public. Information must be updated on a monthly, daily or hourly basis (wherever practicable and meaningful, depending on the pollutant). In addition, it is stated that information provided should include "a short assessment in relation to limit values and alert thresholds and appropriate information regarding effects on health". Moreover Dir. 96/62/EC indicates that: plans or programmes formulated from appropriate authorities in order to combat air pollution and maintain air quality values within limits in certain heavily polluted urban agglomeration should be communicated to the public. It is also stated that when the alert thresholds are exceeded, Member States shall undertake to ensure that the necessary steps are taken to inform the public (Karatzas and Moussiopoulos, 2000). Within the context of compliance with the EU environmental legislation, city authorities are also obliged to provide specific reports to the EU via the EEA on a regular basis.

Also, the Dir. 91/692/EEC: "Standardising and rationalising reports on the implementation of certain Directives relating to the environment" was used to simplify the reporting requirements of the Member States under many environmental directives. Last but not least, a directive regarding the freedom of access to information on the environment has already been put into force from 1990 (90/313/EEC), aiming to ensure freedom of access to, and dissemination of, information on the environment held by public authorities (see previous section).

These directives are one of the main legal aspects for the necessity of information on air pollutant concentrations, provided by EeC. For the determination of the air pollutant concentrations, field measurements and numerical models are necessary, which in turn, need input information from other domains, such as air pollutant emissions, meteorology and topography. Monitoring and reporting actions specified by the EU imply the need for an efficient environmental assessment, which can be achieved only on the basis of efficient environmental data and services.

According to the above, the information to be made available to the public may consists (at least) of

- spatial and temporal air quality and emission data,
- air quality forecasts,
- measures to decrease personal exposure,
- guidelines for sensitive parts of the population and
- administrative details.

Therefore, the information system to address these needs should have the following characteristics

- Ability of treating spatially and temporally distributed data.
- Direct and easy access to AQ information.
- AQ related information easy to update.
- Assess to on-line data.
- Provide easy to understand AQ information in a user-friendly manner.
- Include data aggregation functions to modify data according to decision-maker needs and the needs of the public.

Furthermore, the members of the United Nations Economic Commission for Europe (UN/ECE) signed the "Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters" - the Aarhus Convention, which was expected to come into force by the end of 2001. The latter recognized the importance of electronic tools or other future forms of communication in the preamble to the Convention (preambular paragraph 15) and in the text (article 2,

paragraph 3) electronic forms are expressly mentioned in the definition of environmental information. Besides, there are several other points where the use of electronic tools is supported (article 5, par. 3; article 5, par. 9), as new technology can provide opportunities for efficient, comprehensive and timely provision of relevant information. This was the main aim of the Discussion by the European ECO Forum, the Regional Environmental Centre for Central and Eastern Europe and the United Nations Environment Programme (UNEP/INFOTERRA) for Furthering the Implementation of the Aarhus Convention through the use of Electronic Tools and Media. Moreover, in a recently published report on electronic information tools[1], the Parties to the Aarhus Convention included recommendations on the more effective use of electronic information tools to provide public access to environmental information.

An increasing number of citizens, governments and businesses already use electronic tools and services, such as e-mail, the Internet, cellular phones, display boards and digital television to access and disseminate information. The EU's latest amended proposal or a "Directive of the European Parliament and of the Council on public access to environmental information", that later became Dir. 2003/4/EC declares that the Commission cannot accept a reference to future developments in the area of information and communication technologies, but consider only the available ones. In spite of this statement, the usage of advanced electronic and telecommunication media for providing Environmental Information (EI) has been embodied in the corpus of the official EU documents describing access to environmental information. Moreover, in certain environmental domains (like air quality), the legislative framework describes several levels of EI that should be accessed, that include proper explanations and simplifications towards the public, that no longer constitute EI but stimulate services having EI as a content (Karatzas and Moussiopoulos, 2000; Johansen et al., 2001).

3.2. Air quality information and citizens

The public, as primarily defined in the Aarhus Convention, is meant as one or more natural or legal persons, and, in accordance with national legislation or practice, their associations, organizations or groups. To promote and facilitate the involvement of the public in EI access issues, the Aarhus Convention's Signatories established a task force, so as to take advantage of the possibilities offered by the recent information and communication technologies (http://www.unece.org/env/pp/electronictools.htm).

The Task Force proposed that the development regarding EIS should concentrate on:

- Building the capacities of public authorities in the use of electronic tools;
- Developing common approaches and tools for disseminating environmental information via the Internet;
- Establishing environmental gateways as user-friendly access mechanisms;
- Using the electronic media to raise awareness about the Convention and the opportunities it offers to citizens;
- Working together with non-governmental organisations, the mass media and other users to improve the quality of environmental information and access to it;
- Promoting public access centres in countries with inadequate electronic infrastructures.

Moreover, as stated by the former Environment Commissioner Margot Wallström: Improved access to environmental information is a pre-condition for a higher degree of involvement of citizens and stakeholders in environmental decision-making. This statement should be taken into consideration together with:

[1] http://www.unece.org/env/documents/2005/pp/ece/ece.mp.pp.2005.2.add.4.e.pdf

- Dir. 2003/4/EC: Environmental information should be disseminated by means of available computer telecommunication and/or electronic technology and
- eEurope 2002: Creating an EU Framework for the Exploitation of Public Sector Information: “Public sector information is an important prime material for digital content products and services. It can be the basis for many new information services and products”.

By putting the above statements together one can easily justify the need of citizen-tailored services having EI as the “raw material”, as they are also providing sufficient legal ground for the development of such services. An issue of pan-European importance is the fact that public access and involvement in environmental topics is considered to be a major component of environmental democracy and instrument for progress towards sustainable development. The driving motivating force behind the above-mentioned efforts is the empowerment of the citizens with knowledge that can help them influence the public authorities and decision-makers. As stated in the proposal for the directive on public access to environmental information that repealed directive 90/313/EC (COM (200) 402 final, Brussels, 29.06.2000), “A better informed public is able to carry out a more effective control of public authorities as they carry out their duties in the environmental field, thus securing full and effective enforcement of EC environmental law”. Nevertheless, there are some certain objections concerning public awareness. Factors such as economic considerations, traditions, culture and social issues can interact with knowledge in a complex way and the result may be to either strengthen or weaken the effect of environmental information.

Thus, the need for providing access to environmental information for citizens with the aid of contemporary electronic media has been recognised and is part of numerous legal mandates in legal documents related to public assess to environmental information, and in all relevant legal texts. As an example for the latter, the common position of the European Council (number 41/25.04.2002) on the expected update of Dir. 85/337 and 96/61 should be mentioned, where the use of electronic media for providing environmental information to the citizens is included.

3.3. Air quality management and information systems

Information on the status of air quality is fundamental in order to support:

- environmental planning and decision making by providing scientifically sound information from state-of-the-art tools in a format that is of direct relevance to the decision making process;
- rational use of energy;
- planning actions for emission reduction caused by traffic, industry, power plants and households;
- public awareness on “bad air quality” and its consequence for health;
- the development of standard European air quality indicators.

The key features of an air quality management system should include an easy access to accurate and relevant information on meteorology, air quality and activities leading to air emissions for decision makers in Local or Wide-Area Environmental Administrations and accessible and comprehensive air quality information for the general public. All the information from air quality management systems should be available for the different user categories such as the public, universities and city administration.

The experience from major cities in Europe during high pollution episodes shows that effective and wide spread information is important to obtain the predicted effects on improved air quality, based on the measures carried out. A user-friendly presentation available for the public, which can raise the public awareness on air pollution, leads to a

better understanding of air pollution problems and health aspects related to air pollution. Systems able to integrate air quality forecasts and measurements to assist traffic management decisions are also very much needed by public administrations (see also National ozone forecasting systems and international data exchange in Northwest Europe (1997), R.M. van Aalst and F.A.A.M. de Leeuw (editors), ETC/AQ, http://reports.eea.europa.eu/TEC09/en).

3.4. International and European Public Sector Information policy initiatives[2]

The Public Sector Information (PSI) represents a considerable part of the information production "market" and has been using non-negligible funds to support this production, in order to serve the public, while supporting authorities and various decision making bodies in their administrative tasks: PSI is an important component of the content market and a key economic resource for commercial exploitation. The size of the European content industry is some 433 billion euro, about 5% of European GDP. It is estimated that 12% to 25% of the data used in e-Commerce is sourced from PSI. PSI is therefore a prime content resource (Davies, 2005), while Environmental Information accounts for a considerable percentage of PSI produced (> 50%). This information corpus, produced on the basis of various legislative mandates, is usually disposed to a physical or electronic archive, which is rarely revisited and re-used, although it represents a considerable public investment.

Through the introduction of on-line services (e-Government, e-Health, e-Learning, etc.), governments promote the public interest for enhanced efficiency and effectiveness (European Commission, 2004) and become themselves important suppliers and users of ICT's, thereby influencing their take up.

Within the EU, a variety of important policy initiatives have been undertaken towards the development of a framework for the definition, access and usage of PSI, Environmental Information being the most prominent and massive part of the PSI corpus. The most important of these initiatives are listed in

Table 1, while some of them are presented in detail hereafter.

Table 1 Overview of PSI initiatives

1990	Dir. 90/313/EEC on public access to Environmental Information is adopted
1998	UNECE "Aarhus" Convention
1999	EU Green Paper on PSI is published
2000	eEurope 2002 Action Plan adopted
2001	"Aarhus" Convention enters into force
2002	Proposal on Directive for reuse of PSI
2003	eEurope 2005 Action Plan adopted Directives 2003/98/EC, 2003/4/EC, 2003/35/EC adopted WSIS Action Plan and financial support scheme adopted
2004	Proposal 2004/0175 on INSPIRE Directive adopted
2005	i2010: European Information Society 2010

Directive 2003/98/EC on the re-use of public sector information: The Directive (European Parliament, 2003b) identifies public sector documents as an important primary material for digital content products and services, in the evolution towards an information

[2] Based on the paper of Masouras and Karatzas, 2006.

and knowledge society, one that will become an even more important content resource with the development of wireless content services.

The Directive states that:
"Making public all generally available documents held by the public sector —concerning not only the political process but also the legal and administrative process — is a fundamental instrument for extending the right to knowledge, which is a basic principle of democracy. This objective is applicable to institutions at every level, be it local, national or international."

To this end, it outlines the conditions for reuse of public sector documents, while emphasizing the need for broader cross-border geographical coverage of PSI underpinning Community-wide services and the opportunities for European companies to exploit its potential and contribute to economic growth and job creation.

The explanatory memorandum for the proposal on the Directive outlines the reasoning behind the need for reuse of PSI:

"Citizens and businesses alike can greatly benefit from a good provision of [public sector] information on the Internet. It will facilitate their communication with the public administrations and can increase their participation in the democratic process. Public sector information is very important for democratic and civic life. Equally, public sector information is a key resource for economic activity and proper functioning of the internal market. By increasing the use of public sector information, it is expected that better quality information will be used by a larger group of citizens and companies and that it will allow them to better take advantage of their rights in the internal market."

The Directive recognizes that the considerable differences in the rules and practices of Member States relating to the exploitation of PSI resources constitute barriers to bringing out the full economic potential of this key document resource and proposes that minimum harmonisation and adoption of a general framework for the conditions governing reuse should be undertaken at Community level. It should be noted that the Directive does not mandate reuse in any way, and does not refer to computer programs.

3.5. Future trends

On 1 June 2005, the i2010 initiative was launched by the European Commission, with the stated aims to create an open and competitive single market for information society and media services within the EU, to increase EU investment in research on information and communication technologies (ICT) by 80%, and to promote an inclusive European information society. During the 5th European Information Society Conference that followed, on 2-4 June, local government representatives from across Europe adopted the Krakow Declaration on Local Agenda i2010 and the promotion of digital solidarity among the cities of the world (European Information Society Conference, 2005). The declaration participants stressed the importance of ensuring broadband access, with an eye on promoting PSI use, and of strengthening the enabling role of local and regional administrations in guaranteeing adequate and secure technological infra-structure and in promoting ICT-based inclusive services and applications. To these ends, participants suggested a set of goals as part of the i2010 Local Agenda, to be implemented in all European countries. Goal 1 focuses on the need to support and implement policies in regions and local areas ensuring broadband access to online services for all citizens in Europe by 2010, while Goal 8 specifically mentions the need to expand the use of open source software and open standards in the public sector to increase e-Government interoperability nationally and within Europe.

In addition, developments in the semantic web and ontology sectors that are related to the environmental sector, have been recorded via the number of IST FP6 projects that include these issues in their objectives (http://www.cordis.lu/fp6), while a service-oriented need is emerging, concerning electronic information providence for quality of life, as suggested by the growing number of related services (weather, traffic etc) which are provided via web portals and mobile phone operators. Thus, it is expected that the environment-related public sector will serve as core content for human-centred electronic information services in the future, that will address individual needs on the basis of semantics defined on an individual level. These needs, when combined with cost limitations and flexibility-adaptability requirements, provide sufficient justifications for the usage of open source (Perens, 1998) to support the creation and operation of PSI oriented, environment related, personalised, electronic information services for the support of quality of life and the advance of decision making towards achieving sustainability goals and enhance business perspectives for the ICT market.

3.6. Conclusions on legal aspects

European policy on Public Sector Information, and more specifically information related to the environment, has been strongly suggesting its exploitation for the creation of citizen oriented services, in the frame of empowering democracy and participation, and towards enhancing efficiency and effectiveness of the public sector. In addition, the recent developments attesting to the popularity and usage of Open source by governmental bodies and agencies, and organisations related to the environment, provides proof of concept concerning the creation of quality of life information services on the basis of Free / Open Source software (Masouras and Karatzas, 2006). The need of the citizen to be informed and aware about environmental issues is supported by the legislative framework concerning the relevant right of access, and leads to the conclusion that citizens should also have the right of having access to freely available information and informatics infrastructures and resources, that allow for the creation of personalised services, having direct impact on the living conditions and supporting e-participation and e-governance. This may allow for the “transformation” of citizens from “passive” consumers of information services to active participants in a society based on e-democracy.

4. Overview of existing national solutions in Europe

4.1. Introduction

In the last 10 years, on-line systems have been established in most of the major cities in the EU and in some CEE countries. The collected measurements are used for warning and to forecast air quality as well as to decide if traffic restriction measures have to be applied to reduce the air pollution. In some cities AQ alarms can lead to restrictions in traffic load in the most polluted parts of the city. The fact that the results of the air quality monitoring systems may lead to extreme traffic control measures during highly polluted episodes increases the importance of reliable, high-quality air measurements as well as the fact that they are needed to validate and calibrate the models. Improved quality control and validation of air quality data are also rather important issues. The use of models to provide an accurate 24 hour (and in certain cases 48 hour) air quality forecast are also required by many decision-makers in public administrations.

There are no really good overviews of the air quality dissemination solutions in Europe. In some countries like the UK and Norway, there are comprehensive national solutions covering the whole country. In other countries like France and Greece there are city specific solutions of very good quality but no common national solutions. In countries like Germany, Poland and Switzerland there are regional solutions, of different quality from region to region. In many countries there are hardly any or no public solutions for access to air quality data.

The term Information Dissemination and Presentation Solutions, ID&Ps, which will be used for the rest of this report, is covering all kinds of information channels. In this report we concentrate on Internet solutions since that is the core focus for EEA. However it should be noted that air quality information has been shown, like in the APNEE project (see chapter 7.5) to have potential to be disseminated efficiently and with great value for end users, trough many other channels. As can be seen later in this chapter, some of the more comprehensive national solutions are now also combining more and more their Internet-solutions with SMS push & pull solutions.

Table 2 shows that:

- Just a little more than half of the countries in Europe have on-line IDP solutions
- Most of those countries have a national system, a few have several
- A few have only regional or local solutions
- Very many regional or local solutions exist (Annex A lists more than 100)

This shows the clear need for new initiatives to establish working IDP solutions with on-line data. EEA can play an important role to facilitate this, see part two of this report.

In Annex A most of the included solutions are listed with their web addresses.

Table 2 Overview of on-line air quality IDP solutions in Europe

No.	Country	IDP	National	Regional/local
1	Albania			
2	Andorra			
3	Austria	X		4
4	Belarus			
5	Belgium	X	2	1
6	Bosnia and Herzegovina	X	1	
7	Bulgaria			
8	Croatia			
9	Cyprus	X	1	
10	Czech Republic	X	1	
11	Denmark	X	1	1
12	Estonia			
13	Finland	X	1	
14	France	X	1	20
15	Germany	X	1	15
16	Greece	X		2
17	Hungary	X	1	
18	Iceland	X	1	1
19	Ireland			
20	Italy	X		13
21	Latvia			
22	Liechtenstein			
23	Lithuania			
24	Luxembourg			
25	Former Yugoslav Republic of Macedonia			
26	Malta			
27	Moldova			
28	Monaco			
29	Netherlands	X	1	1
30	Norway	X	1	
31	Poland	X		13
32	Portugal	X	1	
33	Romania			
34	Russia			
35	San Marino			
36	Serbia and Montenegro	X	1	
37	Slovakia (Slovak Republic)	X	1	1
38	Slovenia	X	1	
39	Spain	X		2
40	Sweden	X	1	10
41	Switzerland	X	3	11
42	Turkey			
43	Ukraine			
44	United Kingdom	X	1	8
45	Vatican City			
	Number of countries:	**24**	**19**	**15**

Comments to the table:
The table might be incomplete due to difficulties in accessing the content of the many sites with only national language. However, it should give a fair impression of the situation in Europe. The requirement to be listed is that the web solution presents on-line data (at least updated daily) of selected air quality measurements. National solutions can have sub sections of their solutions with regions and or cities of the country.

4.2. Trans national solutions

In addition to the national and regional/local solutions there are at least 3 trans-national solutions with live data (in addition to the EEA ozone web):

The Prevair solution	
Type of solution	National and central Europe
Web address	http://www.prevair.org
Languages	French and English
Owner/Editor/operator	The French Ministry for Ecology and Sustainable Development (MEDD) coordinates the PREV'AIR project.
Description	The PREV'AIR system was implemented in 2003 upon an initiative by the French Ministry for Ecology and Sustainable Development (MEDD) with the aim of generating and publishing daily air quality forecasts and maps resulting from numerical simulations on different spatial scales. The system also supplies observation maps based on measurements carried out on site.
Compounds covered	Ozone, NO_2 and PM_{10}

The TAQI solution	
Type of solution	Central Europe
Web address	http://airce.info/en/
Languages	English, German, Czech, Slovakian, Hungarian
Owner/Editor/operator	TAQI (Transnational Air Quality Improvement) – subsidised by the European Regional Development Fund (ERDF), is the organisational background for the idea to inform the public about air quality and cross-border transport of pollutants in the Central-European area.
Description	The transnational project area comprises the following: Lower Austria, Vienna, Burgenland (Austria) West Slovakia, (Slovak Republic) South Bohemia and South Moravia (Czech Republic) Györ-Moson-Sopron County, Vas County, Zala County, (Hungary)
Compounds covered	SO_2, NO_X, NO_2, O_3, PM_{10}

The Ostluft solution	
Type of solution	Ostschweiser kanton und Lichtenstein
Web address	http://www.ostluft.ch/main.php?section=messdaten
Languages	German
Owner/Editor/operator	Ostluft
Description	
On-line data	Hourly updated
Compounds covered	Ozone, NO_2, PM_{10}

4.3. International solutions

Several international solutions exist that might be worth studying for ideas for content and functionalities. Some are:

http://www.airnow.gov/ is a cross-agency U.S. Government Web site on air pollution. An interesting feature is the animations on the 20 min changes of all monitoring site values.

http://www.aacog.com/Air/Alert/default.asp Air quality and your Health in Southern Texas. Air Quality Health Alerts.

http://www.airkorea.or.kr/airkorea/eng/airkorea/main.jsp. This is a web-based real time air quality system for Korea, with a nice graphical representation of the geographical details of the area and the related AQ measurements.

http://www.msc.ec.gc.ca/aq_smog/index_e.cfm. This is the Meteorological Service of Canada's Air Quality Services website, providing a PDA interface.

http://www.smogcity.com/. This is an interactive, simplified, air pollution simulator that shows how emissions, environmental factors, and land use contribute to air pollution.

http://travelcalculator.org/ This calculator has been produced to encourage everyone to reduce the environmental impact of his or her travel. It aims to show how using transport with a relatively low environmental impact can help you to reduce air pollution, improve your health and in some cases save money. There are three calculators - to calculate pollutant emissions from your journeys, calculate the energy you use on your journeys (in calories), and calculate the full annual cost of car ownership.

5. Scientific studies recent years

Research on Air Quality Science related to AQ Information Services is part of AQ Management research. It has a long-standing record in the EU, as it has been part of the FP activities for many years. This is an applied research activity, and thus should be examined in parallel with the development of the AQ management and assessment legal framework. Thus, the publication of the so called Framework Directive on ambient air quality assessment and management (96/62 EC), "ignited" research on issues related to the assessment and management of the quality of the atmospheric environment, with emphasis in urban areas, underlining the importance of ICT technologies towards Air Quality Management and Information Systems (AQMIS).

5.1. European Union AQMIS research: the 4th FP

ICT and analytical tools such as simulation models may be combined into powerful information and decision support systems, in order to provide relevant information to the management and decision making process. On this basis, the EU has been supporting relevant research under the IST research umbrella, following the publication of the Directive 96/62. This was the time of the 4th FP, and the research priority was then called: "Telematics Applications Programme: Environmental Sector". The projects of that time that were directly or indirectly related to the dissemination of AQ information included: ECOSIM, EFFECT, EMMA, ENVIROCITY, IRENIE, REMSSBOT, SIGMA and TEMSIS.

All these projects investigated the benefits of providing access to up-to-date environmental information to citizens and to local and regional or national authorities across Europe. Through several telematics systems and services they facilitated information and data flows between various actors. This service was required by authorities in order to make real-time decisions, save time and increase efficiency in environmental monitoring in urban and rural areas. The following keywords and phrases reflect project objectives as well as what they have in common: User interfaces, Air Quality Indices and Changes, AQA Information, AQ modelling, Data quality, access to data and security matters, System architecture, Network and WWW technologies, GIS, Licensing of Emissions, Marketing of products and services, Validation Sites, Environmental management and strategic planning, etc.

These projects developed and demonstrated tools and services for the following inter-related applications:

1. Air quality monitoring, forecasting and warning systems (EMMA, ENVIROCITY, EFFECT, ECOSIM, IRENIE).
2. Integrated traffic management and transport planning exploiting on-line traffic measurements and Predicted air quality information (EMMA, EFFECT).
3. Identification of sources of air pollution linked with emergency management systems for provision of information to health organisations and the broad public (EFFECT).
4. Integration of environmental data from heterogeneous data sources (REMSSBOT, TEMSIS, EMMA, SIGMA).
5. Communication with and dissemination to the public, processing of environmental information for easier and more effective use by administrations and the public (ENVIROCITY, EMMA, REMSSBOT, TEMSIS, IRENIE).

5.2. Basic project characteristics

In the frame of the aforementioned projects, a number of tools and services were designed with special emphasis on being inter-operable with existing systems and networks, while also being portable from one application site to another. All projects ran their demonstration phase in urban areas, and in European regions. As the focus was on user and organisational needs and on cost-effectiveness (rather than being technology-driven), projects reduced the time for development. By also considering usability, less training and support and documentation was required to achieve the goals with effectiveness, efficiency and satisfaction on the users' side.

With regard to data production and co-ordination, projects were directed towards providing a service to each of the cities within the consortia. It was noted, that data compatibility and data quality control would allow greater flexibility to transfer the final product to a variety of users. The most critical issues addressed were: data collection (type of data, frequency, and data quality), the location of the monitoring stations, the transmission network used, and the modelling and forecasting capabilities of the systems. Projects included the assembly and operation of working databases using information provided by a variety of public and private sector sources. Whilst initially these data was being provided to the projects, it could be seen that in the future consideration needed to be given to controlling access and security, while in some cases billing and payment arrangements should be made. One problem that emerged had to do with data comparability. AQ Data was not comparable as the frequency of sampling, the methods used, the parameters measured, and the standards applied varied significantly across the environmental domains of the atmosphere, soil, surface and groundwater. In addition, there was a variety of differing computer models being deployed within the projects, while the use of models for AQ assessment was an issue of importance, triggering workshops and collaborations.

As a common feature of the various projects, Web sites were developed for communication with the public, but other media were also used, such as TV, Radio Broadcasting and kiosks' screens in public places (e.g. ENVIROCITY, EMMA, TEMSIS, EFFECT). The potential user (administration and the public) was supposed to pass through a period of "education and training" in order to increase the projects potential for acceptance and success. With regard to public interaction and the dissemination of information, there was a common interest in the technology and methods of the dissemination/format of information and the methods to control the dissemination process. This was particularly relevant for the interaction with the general public using Public Information Points, Public Access Terminals, World Wide Web, Variable Message Signs, Radio Data System-Traffic Message Channel (RDS-TMC) etc. The ability to communicate with a variety of users with different information needs was also noted. In addition, it was identified that there should be a way to provide an "interpretation" of the AQ data to target the appropriate message to specific sectors of the public.

5.3. European Union AQMIS research: 5th and 6th FP

Within the 5th FP, a number of IST related projects addressed, again, the issue of air quality management, information, and systems. The reference project was APNEE and its take-up measure APNEE-TU that addressed, for the first time, the needs of the citizens for personalised information services for the quality of the environment they live in, and developed an umbrella of pull and push services that can be used for providing AQ information to the public. See chapter 1.2 for more details on these projects.

APNEE and APNEE TU provided a holistic approach to AQ information management and dissemination, and are a reference of success for EU projects, serving as a guideline

for further development and implementation. These projects also addressed, for the first time, the issue of presentation and interpretation of AQ information, and suggested an intuitive way of communication, on the basis of simple text field and accompanied graphical representation of AQ nominal values.

This idea influenced projects like ENV-e-CITY within the econtent/IST, which provided a one stop shop of AQ related scientific services for administrators and practitioners. The same idea also inspired project MARQUIS, within the 6th FP, e-content/IST, which suggested an automatic interpretation of AQ information and variations on the basis of a machine learning algorithm, accompanied by multilingual text generation, via proper linguistic engineering methods. In addition, other EU R&D initiatives like Interreg also provided support to projects related to the presentation of AQ information. The example here is CITEAIR, a project that suggested a common AQI and provides EU cities with the opportunity to "link" their AQ data to the project website, so that citizens will have the opportunity to compare cities and develop a general overview of AQ in various European regions. It should be noted that in parallel, a number of basic and applied research projects on AQ were undertaken, as it can be seen via projects in CLEAR (Cluster of European Air Quality Research) and SATURN.

5.4. Other related projects and applications

A number of projects that were/are supported by national funding or local government aimed at providing environmental information services. Some of these projects were selected to be presented hereafter, and include:

- The OASI project[3] - Integrated Monitoring and Decision Support for Environmental System. OASI is a system for regularly and automatically collecting environmental data from a network of hundreds of sensors distributed throughout the Canton of Ticino in southern Switzerland. It has been in successful operation for several month (http://www.ti.ch/dt/da/spaa/temi/oasi/

- The MINNE project on Mobile Environmental Information Systems and Services. MINNE is an interdisciplinary research project in the area of Mobile Environmental Information Systems, at the University of Oulu, Finland. In order to employ the required expertise, the project involves a consortium comprised of three departments: Information Processing Science, Biology and Geography. The aim of the MINNE project is to explore possibilities for ambient aware, location-based services (LBS) using mobile devices in the domain of environmental information systems (http://www.minne.oulu.fi)

[3] E. Arauco and L. Sommaruga (2004), Web Services for Environmental Informatics. In Rizzoli, A.E. and Jakeman, A.J. (eds), Integrated Assessment and Decision Support, Proceedings of the First Biennial Meeting of the International Environmental Modelling and Software Society, iEMSs: Manno, Switzerland, 2002. ISBN 88-900787-0-7)

- www.lorano.de. Application for pollen information

Vodafone Germany

Help for allergy sufferers: up-to-date pollen alert forecasts from Vodafone live!

- The pollen alerts take into account the user's personal allergy profile and current location
- Also available by SMS text message

Düsseldorf, 18 May 2004. Allergy suffers can breathe a sigh of relief: from now on, the Vodafone live! portal will be providing a personal pollen alert forecast service to its users. This service enables them to avoid risk areas or to take medication in time to alleviate their allergy symptoms. The service is unique because it takes the user's personal allergy profile and current location in the German Vodafone network into account.

- Smog Alert: SMS air pollution information service in Hong Kong

SUNDAY Launches "Smog Alert" -- Hong Kong's First Location Based Air Pollution Index Service Available via SMS

November 10, 2004

HONG KONG, November 10, 2004 -- SUNDAY Communications Ltd. (SEHK: 0866; NASDAQ: SDSY) today announced the launch of "Smog Alert", Hong Kong's first location based Air Pollution Index (API) available via SMS.

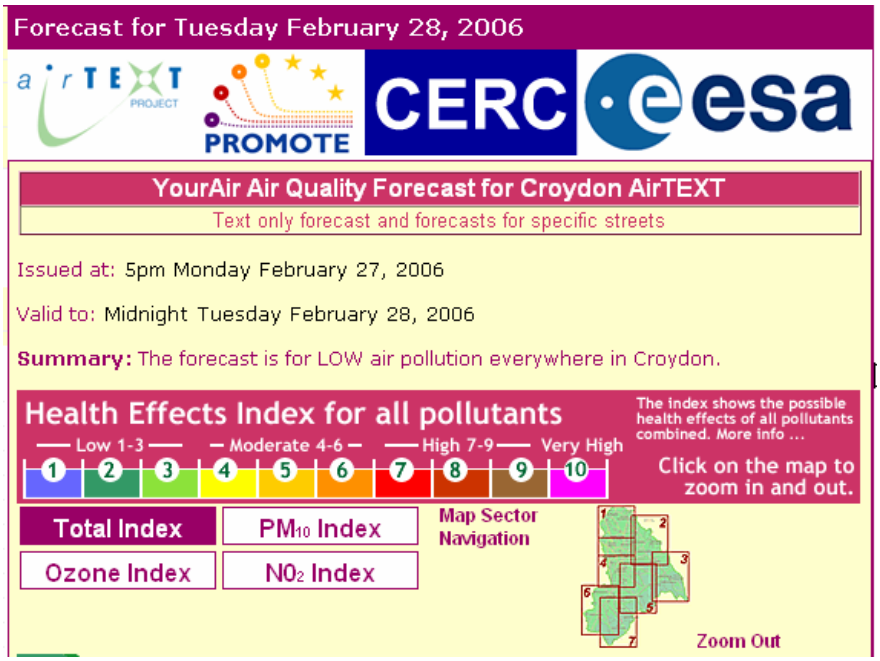
"The air quality in Hong Kong obviously concerns all of us," said Bruce Hicks, Group Managing Director, SUNDAY Communications Limited. "Smog Alert is SUNDAY's latest location based service that provides real-time information. Just press a few digits on your SUNDAY mobile phone to determine the Air Pollution Index wherever you are, shopping or having fun. The quality of air varies across Hong Kong - so, if you want to know what the air quality is your location, just use Smog Alert."

- YourAir project, which, according to the related web site (http://www.cerc.co.uk/YourAir/About.htm) is the world's first air quality forecasting system that tells you about the pollution in individual streets. The forecasts allow you to make decisions on traffic control, journey planning or personal health where sensitivity to air pollution is a problem. It is a public information and education tool that includes facilities to broadcast air quality alerts to selected vulnerable individuals by email or SMS messaging, all at very low cost.

- AirAlert: an air quality SMS information service for asthmatic in Sussex, UK. This is a pilot service, provided by the Sussex Air Quality Steering Group (SAQSG), which will send free messages to your mobile or home telephone, informing you that poor air-quality is predicted in your area of West or East

Sussex. http://www.sussex-air.net/

- AirTEXT. An Air pollution SMS pilot information service for Croydon, UK



- Tsunami alarm. A Germany-base service for SMS warning for Tsunamis world wide

5.5. Related initiatives

A number of EU initiatives like the eEurope 2002: Creating an EU Framework for the Exploitation of Public Sector Information[4], the CAFÉ programme (Clean Air for Europe) and the INSPIRE directive for spatial information in Europe[5] have a high influence on AQ information services. In addition, the GMES initiative includes, among others (via the PROMOTE-2 project), the dimension of AQ information services for citizens, while a number of other initiatives, undertaken by research organizations, local government or the European Environment Agency are underway[6]. Moreover, it should be noted that a large number of EU or nationally supported projects investigate open questions in the AQM science, related, among others, to the physical and chemical processes involved, and the needs that are voiced by the implementation of the related directives. For the latter, the use of models seems to be among the most important aspects that are being investigated. It should be noted that the variety of agendas addressing AQM and information needs spans from governance to enhanced participation of citizens to decision-making, and from sociology to environmental education. It is therefore evident that a specific approach is required, in order to improve the usage of AQ related information services. A proposition on this direction follows in the next section.

5.6. Human-centric environmental information services[7]

As more than 60% of the European population lives within urban areas, city life has become the main "living mode" for the majority of the European citizens. This fact creates a pressure for providing transportation, energy, telecommunications, social and financial services. Citizens make use of service infrastructures available in order to fulfil their needs and by doing so they influence the sustainability of the environment they live in. The basic operation of cities has not changed from the time of the Athenian democracy, where a citizen was expected to hold opinions about societal issues and be actively involved in efforts towards the betterment of the city, but the means used for service provision have been enriched by technological advancements to a tremendous degree, now embracing the capabilities of the IT technologies. The latter have also created an urban concept that runs in parallel with the physical one, and is the concept of the virtual city, as represented by Internet-based city services, personalized WAP, SMS and voice services, and remote health care options.

A further step towards the virtual city is the creation of intelligent regions, where concepts created in the framework of industrial activities for Integrated Product Policy are now being used for the creation and management of services related to mobility, social awareness and personalized well being. These issues create the backbone of the sustainable human-centric development and act as the supporting mechanism for human centric environmental information services towards sustainable living.

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4 Public sector information is an important prime material for digital content products and services. It can be the basis for many new information services and products

5 The directive, which was approved on the 22nd of Nov. 2006, includes, among others, "he principles according to which citizens should be allowed to examine the official maps and other spatial data covered by the directive, and rules for granting authorities access to data held by other authorities", http://www.eu2006.fi/news_and_documents/press_releases/vko47/en_GB/175161/

6 Workshop on Real time air pollution data exchange and forecast in Europe, 7- 8 April 2005, EEA, Copenhagen, Denmark; 11th EIONET Workshop on Air Quality Assessment and Management, La Rochelle, 26-27 October, 2006.

7 Based on *Karatzas, K. (2003) Environmental Informatics: Concepts and Definitions, Proceedings of "The Information Society and Enlargement of the European Union"-17th International Conference Informatics for Environmental Protection, A. Gnauck and R. Heinrich eds., Part 1: Concepts and Methods, pp. 146-151, ISBN 3-89518-440-3*

In addition to the above, one may envisage user-friendly, human-centric environmental information services as a way to improve the overall quality of life in the city and enhance citizen participation. A prerequisite of such services is the operation of an "electronic city", which will provide ("broadcast") all environmental information for free, on the basis of, e.g., predefined semantics and XML data schemes. This should be done with the aid of an amendment to the directives on public access to environmental information. In this way, the introduction of human-centric, environmental information services is expected to add a positive conceptual (in equivalence to physical) attribute to the urban environment, as it will increase the people's feeling for access to services, facilities and amenities, that plays an important role in the perception of quality of life (Sénécal, 2002[8]).

It should be noted that personal well-being is an essential part of sustainable development, and is highly influenced by the quality of the environment where people live. Although the discussion about sustainability has been initiated some years before, there seems to be a "bottleneck" between "getting informed" and "be able to act" towards the improvement of the quality of life. The vast usage of electronic information channels has been supporting the exponential growth of the former, while failing to support an equal development of the latter. Some possible ideas on follow-up quality of services in this direction, include:

- Quality of life impact estimations on the basis of a personalized "profile" and by making use of "dosage" data
- Air quality related health impact assessment on the basis of "dosage", for both in-door and out-door environments (very interesting scientifically, but not possible until today)

Overall, Quality of life may be used as the basis of advanced, human –centred information services. In addition, city authorities should be prepared to migrate from static to real-time interactive environmental administration systems. Thus, a new service-oriented relationship between city authorities and the public is emerging, based on environmental information availability and applied use of ICT innovations.

8 Sénécal G., (2002): Urban Spaces and Quality of Life: Moving Beyond Normative approaches, Horizons 5, No. 1, pp. 20-22, http://policyresearch.gc.ca/v5n1_e.pdf

6. Analysis of trends in state of the art national AQ dissemination systems

For this analysis we have concentrated on the three dominating information dissemination solutions in Europe;

- UK: British national solution which covers all of UK, but several regional and other solutions exist in UK
- Norway: National solution. Covers all cities, no other solutions exist
- Paris: Solution operated for the Paris area in France. Other national and many local/regional solutions exist

All the responsible organisations/companies behind the three are working hard to establish state of the art solutions and run constant improvement programs for their solutions. All three have been rebuild and extended with new features over the last years, and have also been actively involved in different research programs.

The three solutions have been developed independently of each other and there has been very little contact between the persons/organisations behind. Despite being quite different in structure, content and functionalities, there are some very important lessons from the evaluation of these three solutions.

6.1. United Kingdom national solution

The UK air quality archive has been viewed among air quality scientists and experts as an excellent example of data information system for many years. Given the huge amount of data from air quality monitoring, the solution has clearly been a success and of great value from the point of view of scientists and researchers. The challenge has been to both provide the experts with all data and at the same time give easy enough information to the general public.

Type of solution	National
Web address	www.airquality.co.uk
Languages	English
Owner/Editor/operator	Developed by NETCEN, part of AEA Technology Environment, on behalf of the UK Department for Environment, Food & Rural Affairs and the Devolved Administrations. Operated by NETCEN on behalf of same departments.
Description	Covers all areas in UK. Contains status, forecasts, emissions, news, reports, facts etc. Very comprehensive database of all measurements.
On-line data	Hourly updated
Compounds covered	PM_{10}, NO_X, CO, SO_2, ozone + many more in the archive
Remarks	Major update autumn 2006.

Figure 1 The new web site for UK air Quality archive

The new edition was launched in the autumn of 2006 with a new layout and interface with better chances of being actively used by many more citizens. A lot of work and tests towards end-users has been done to redesign the solution for the benefit of the different user groups. The changes have been very well received among citizens in the UK.

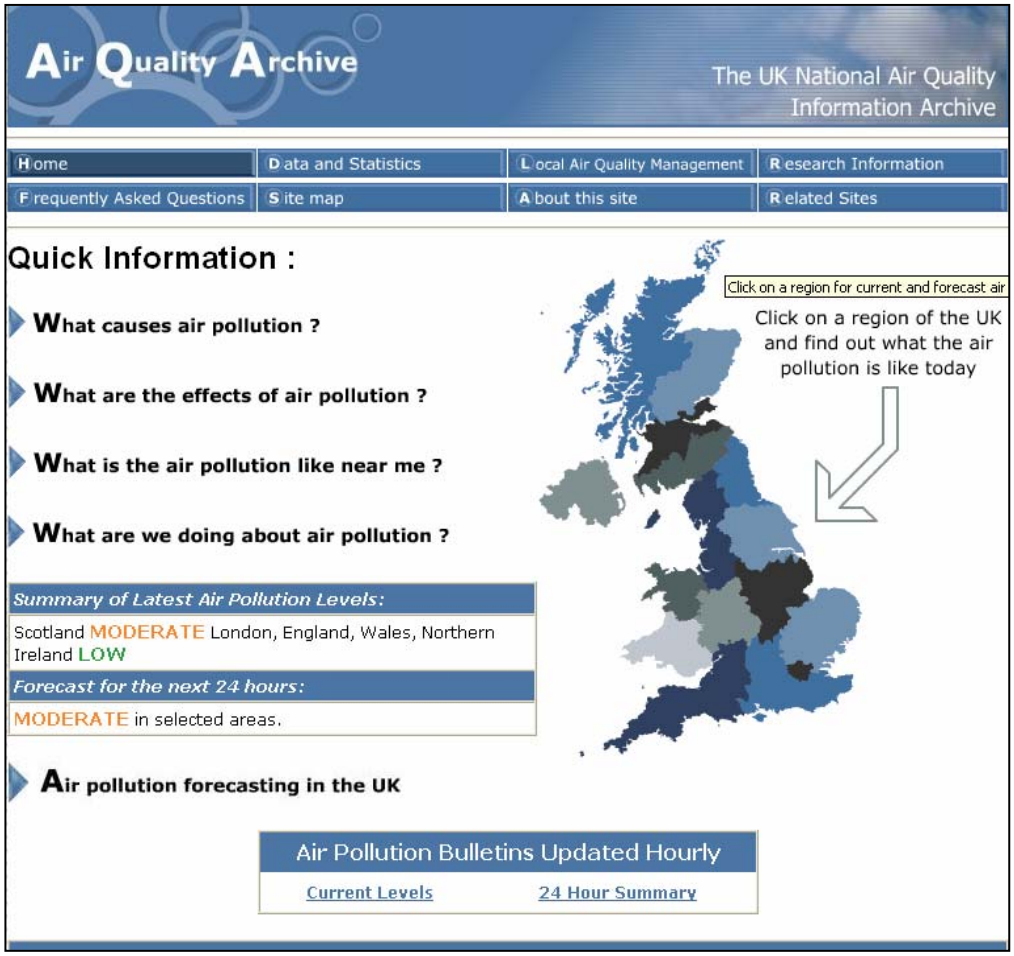

Figure 2 The previous web site for UK air Quality archive

6.2. Norwegian national solution

The Norwegian national web dissemination solution is a unique solution in the sense that it covers all cities and regions in the country. Some years back there was a movement to establish individual solutions in the different cities, but through consultation between national authorities and local authorities, a plan for a national common solution was established.

The challenge has been to establish a solution that all parties are comfortable with without having to make to many compromises. At the same time it was important to ensure the needs of both the citizens and the experts.

Type of solution	National
Web address	www.luftkvalitet.info
Languages	Norwegian
Owner/Editor/operator	Developed by the State Pollution Authority together with the National Public Road administration and the Norwegian institute for Air research (NILU). Operated by NILU on behalf of the three.
Description	Covers all 11 cities included in the national monitoring program of Norway as well as the ground level ozone network and UV monitoring stations. Contains status, forecasts, compliance views, news, reports, facts etc.
On-line data	Hourly updated
Compounds covered	PM_{10}, $PM_{2,5}$, NO_X, CO, SO_2, ozone, UV and ozone layer
Remarks	Will be rebuilt early 2007.

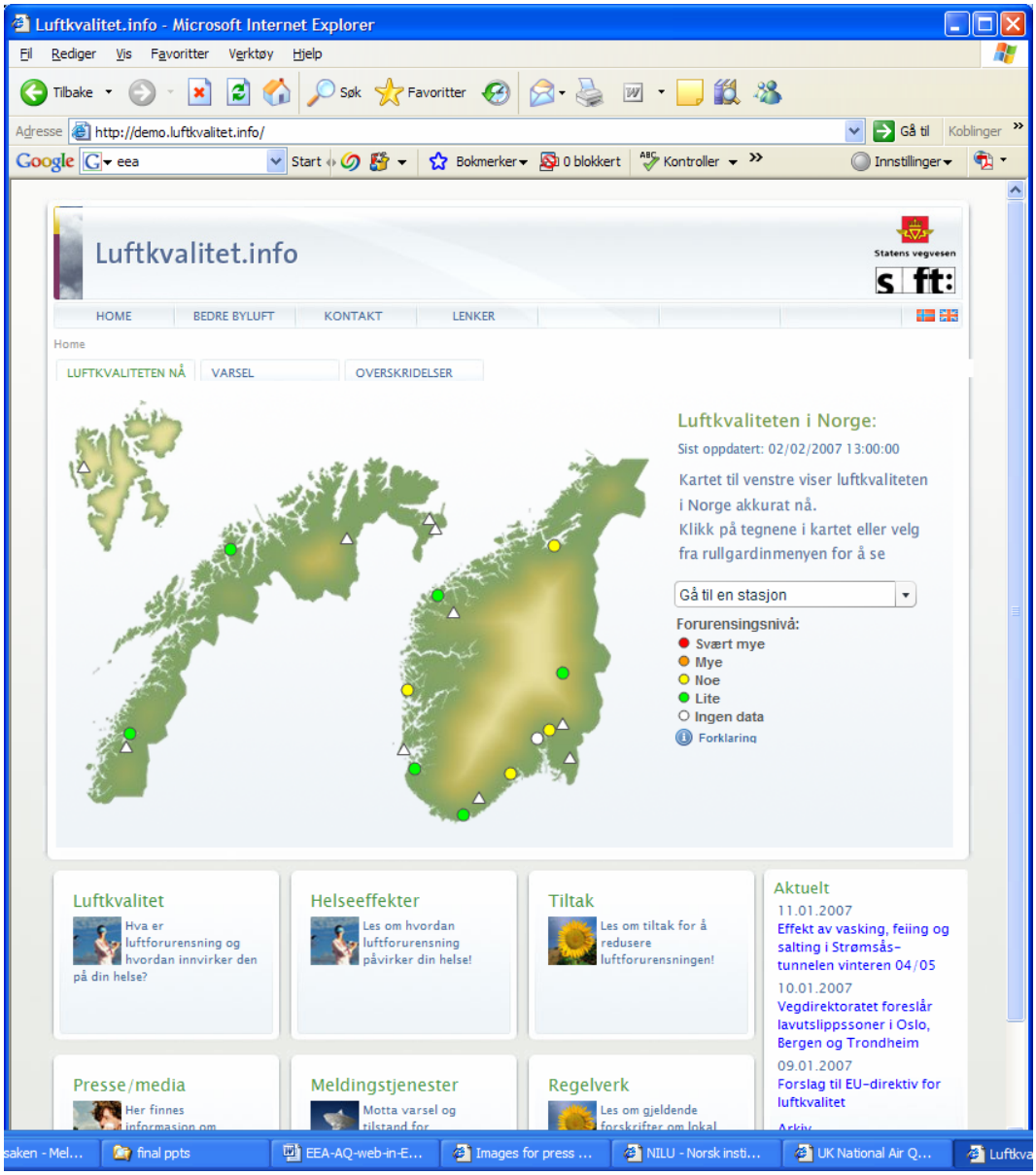

Figure 3 Draft edition of new web site for national web solution in Norway

The plan is to launch the new version for Norway in Mars 2007. It will have a better interface and tuned functions for general citizens.

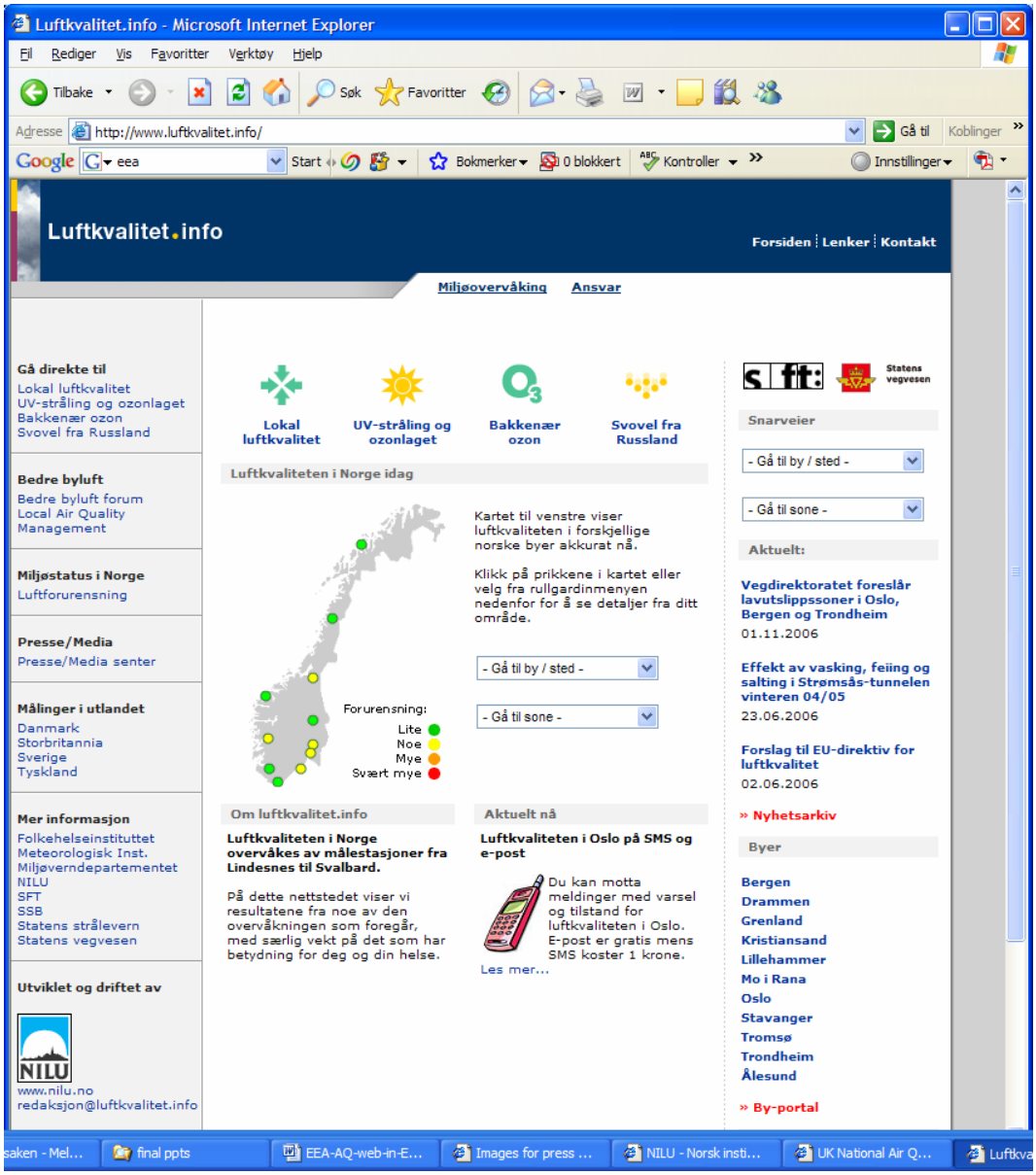

Figure 4 The previous web site for national web solution in Norway

6.3. Paris region

The AQ solution for Paris region has been viewed as the most comprehensive air quality information dissemination solution on a regional level for many years now. It covers a huge amount of great functionalities and is well tuned towards different types of end-users. It is constantly reviewed and updated and the plan is to launch an update during 2007.

Type of solution	Regional – Paris region
Web address	www.airparif.fr
Languages	French and English (Part of solution)
Owner/Editor/operator	Developed and operated by AIRPARIF themselves.
Description	Covers all of Paris region Contains status, forecasts, emissions, news, reports, facts etc.
On-line data	Hourly updated
Compounds covered	PM_{10}, $PM_{2,5}$, NO_X, CO, SO_2, ozone, BETX + many others from manual measurements.
Remarks	Will be updated 2007.

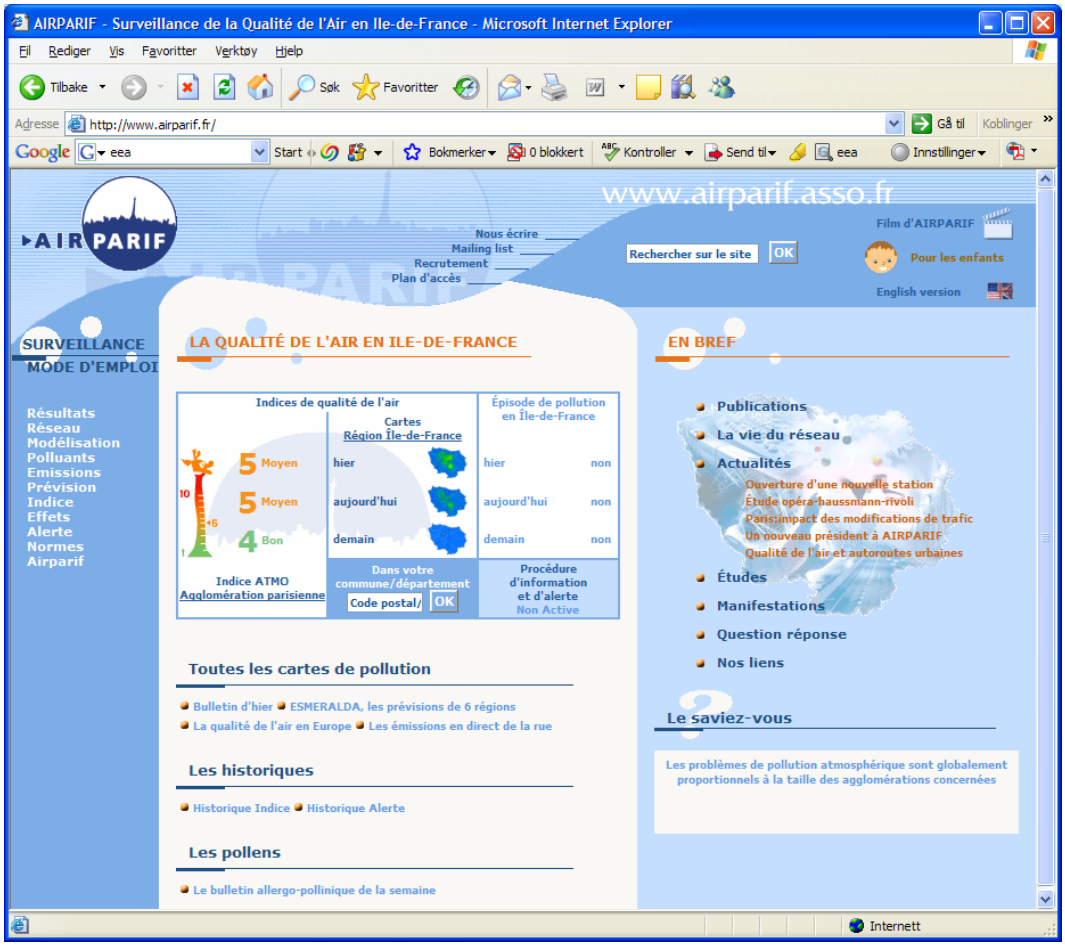

Figure 5 The web site for the Paris region

The new edition will extend the possibilities for the end users to get exactly the information they are interested in, in an easy accessible manner.

6.4. Important aspects about the three solutions

Given the fact that these three solutions have been developed independently of each other over more than five years, they demonstrate surprisingly important similarities. The layout and graphical design is considerably different in all three solutions, but there are other similarities that are worth noting.

The three solutions have some other common features that is important to highlight, since these features are considered by the owners/operators of these solutions to be important for the success of the solutions:

- **Forecasts**
  All solutions have developed 24h forecast for tomorrow (Paris and UK), and 24h&48h forecasts for tomorrow and day after (Norway). The forecasts are based on the latest observations, and meteorological forecasts used in model runs and statistical analysis. Forecasts are furthermore made for different areas and thereby the users get specific valuable information ahead of episodes and can act to avoid exposure. Forecasts are made by local air quality experts who write the forecasts in such a way that it works as a communication, similar to "chatting" with the citizens every day. In this way the forecasts work excellently and are interesting to retrieve day after day (not possible with fully automated systems).

- **Simple front end**
  All three solutions have a relatively simple front end. Use of colour symbols, with an easy to understand four (UK and Norway) or 10 level system (Paris, ATMO index) with no actual air quality concentrations. Furthermore, a limited specification between types of pollutants is given. All solutions have full details available for the more interested users, but all have increasingly tuned towards more and more easy to understand front interface.

- **Operated by trusted national authorities**
  It is considered to be very important to establish the necessary trust between end users and data/information publishers. All the solutions are actively operated and fully controlled by the highest level of authority, either on national level for the British and Norwegian solution or on local level for the Paris solution. No problem with trust in data has been encountered by any of these three solutions based on this ownership and operation.

- **Complete coverage of data**
  All solutions contain all the relevant monitored data in the area they cover. This means that the users can get all necessary information from these sites alone (one stop shop). Furthermore, all solutions have comprehensive views of details for all who like to see all details in tables of graphs. Nothing is hidden, all data is available.

- **Health information must be included**
  A clear consensus among the three solutions is that the health implications of an AQ forecast or status must be provided. This is considered far more important than giving the actual concentrations and compounds. The health warnings should also be coupled with an action recommendation especially for vulnerable groups.

- **Extra features for data providers**
  An interesting aspect that is particularly highlighted by the two national solutions (UK and Norway) is that they both have considerably extended features for data analysis, visualisation and exporting of data for the data providers on password protected pages. This is viewed to be a critical success factor in getting the data providers to keep up their part of the work to ensure a steady reliable dataflow.

6.5. Lessons learned from the new developments of the three solutions

If we concentrate on the latest developments over the last two years for the three sites studied in particular, one can see again very similar developments. Some have got further on with new developments than the others, but they are more or less going down the same route: towards increasingly service-oriented solutions.

6.5.1. Focus shift from information to services

By studying the development of the three mentioned solutions, it is evident that they are somewhat following a common line of "maturation". They have all started with the purpose of responding to legal mandates on "something that needs to be told" (fulfilling the needs of the information providers), and are more and more developing into solutions that are adjusted to the needs of the information recipients rather than those of the senders. This typically happens when making a good solutions that show data correctly is not good enough any more, but the solution has a goal for wide spread use, typically as part of a broader environmental/health information policy. All solutions therefore tend to be more service than information oriented.

6.5.2. From web to multi-channel

A clear tendency is that the solutions, being initially web based, also provide extracts of the data in suitable formats for printed media, TV and radio. Furthermore, subscription to e-mail of status and/or forecasts as well as SMS subscriptions of the same are already established or under constructing. This is all part of becoming more of a service provider, tuned to the end-user needs.

6.5.3. Tailored solutions

All solutions are slowly being extended with new content for specific user groups. These may be young people, teachers, health people, media etc. None of the solutions have so far developed modules where the users can design their own pages and select what to view, but they are all discussing it.

6.5.4. From status to forecasts

A clear tendency is that forecasts get an increasingly centralised place. It gets more and more space and becomes more and more the "selling" content. This is based on end-user feedbacks that forecasts are the most valuable content for very many users.

6.5.5. Compliance views

A new element, which has been established in Norway, but not yet in the other two, although they have shown great interest, is a compliance view section next to monitored data and forecasted data. This section shows the approved datasets in relation to national and EU law of local air quality. It shows the exceedences of the threshold levels in days/hours compared to the allowed exceedences. This feature gives an excellent tool for mangers in Norway, NGOs, media and politicians interesting in accessing the situation and improving air quality in practise.

6.5.6. Faster and faster dataflow – get it live

It is a clear goal for all solutions to obtain a faster and faster dataflow. They all run on hourly data, but the delay from the hour has passed and until the data is on the web differs. They all have it as a goal to get as close to a few minutes passed the hours as possible. This is mainly a cost issue since data acquisitions systems nowadays can be replaced by live web-servers and live data loggers on each instrument/station, thereby giving practically live constant feed.

7. Results from test studies[9]

The most comprehensive research and test with real end-users on how to disseminate air quality data was performed within the Air Pollution Network for Early warning and on-line information Exchange in Europe, APNEE project (www.apnee.org), see chapter 1.2. The conclusions from this work were further elaborated in the Metropolis project (METROPOLIS was a multidisciplinary thematic network funded under the 5th Research Framework Programme). Its main goal was to improve the performance of environmental measurements and monitoring systems in support of EU policies (http://www.metropolis-network.net/).

A variety of results came out of these projects and the findings have been used in many different ways by national and international agencies in designing environmental information dissemination solutions. The main new issues studied in relation to improving Environmental Information Systems (EIS) in these projects have been (Karatzas et al., 2005):

1. Extensive use of on-line data
2. Use of forecasts
3. Geographical referenced content
4. Push services
5. New dissemination techniques

These five issues have important bearings for the further recommendations of the EEA AQ web in part 2 and is therefore here briefly summarised.

7.1. Extensive use of on-line data

In the APNEE and APNEE TU projects a test panel investigated several information dissemination solutions. It is clear that the use of on-line data was the primary success factor in all solutions tested. In fact none of the various services, except for the Internet is of any interest without on-line data.

Looking at the overall results of user feedback on the offers provided by APNEE, more than 80% of the persons that participated in the field test (estimated number of approx 2500 participants within the project life cycle) in all countries were generally positive to the offer. The challenge in use of on-line data is that the amount of data becomes tremendous, while special care should be taken for quality assuring the information provided. This might result in difficult-to-use solutions. However, more than 70% thought the solutions provided in APNEE TU were easy to use.

Colour coded indexes was well received and understood as information content and overall AQI worked better than compound levels. For instance informing the end user that the air quality situation in a city is now ‘moderate’ in combination with the use of colour or symbols is shown to have a higher probability of being correctly understood, than referring to the observed concentrations of PM_{10} and NO_2.

The APNEE projects have shown that it is technically possible to build efficient, stable and advanced dissemination systems using on-line data in combination with modern air quality management systems, and make the end results useful and interesting for the general public as well as experts.

9 *Based on Marsteen, L. and Endregard, G. (2004) METROPOLIS. Work Package WP3/Deliverable 4. On-line data presentation and data distribution. NILU publication OR 69/2004*

7.2. Use of air quality forecasts

It is clear from the end-user investigations in the APNEE projects that forecasts are probably the most interesting content, especially for people with health problems related to air pollution. Using the forecast they can plan their whereabouts on days with high pollution. Forecasts can be made by different technical set ups and disseminated effectively in various ways.

Ideally the authorities want a model that produces ”correct” forecasts consistently. They do not want to respond to forecasted episodes that did not happen or fail to respond to episodes that the systems did not predict. Using a fully automatic system with model results from dedicated air quality management systems or air quality models running on fixed intervals is a challenge because the results depend on the quality of the statistical datasets used for the calculations as well as the meteorological forecasts. There for it is actually better chance to get best possible forecasts when one use such systems to provide the background data for the operator making their forecasts, then based on model results and experience in combination.

7.3. Geographical referenced content

The end-user investigations in the APNEE projects indicate a questionable effect of the geo-referenced information systems. For services like e-mail and SMS, maps are not really of importance. Maps on the Internet showing concentration distributions seems to be a useful visualisation, but the more easily understood AQIs in combination with symbols seem to work better. Maps seem to be a better approached as extra information for advanced users.

Many users travel through different parts of the city and their travel patterns might change during the week. Therefore receiving general information for the city, and thereby knowing the overall situation, seems to be better than only receiving information from a smaller defined area.

7.4. Concept of push services

The end-user investigations in the APNEE projects indicate that push service is an interesting information channel, especially for specific interest groups, like people sensitive to air pollution. People suffering from allergy and asthma rated the alert by SMS service highest. During a field trial in France, SMS messages were pushed according to three rules: in case of forecasted air pollution episode for the following day, in case of detection of a pollution episode and in case of an ATMO index higher than 8. People’s response to the service was good, even affecting people’s behaviour to some extent.

Many users complained about information overload, especially when the system pushed messages every hour during air pollution episodes. The users primarily want information only during peek episodes and for many the preferred interval was less than once a day. It is important to keep the number of options at a minimum, as too many possibilities tend to confuse people. On the other hand, it is important to provide with easy customisable and personalised information services.

7.5. Use of new dissemination techniques

Summary of available techniques:

- Internet — On computers (and various mobile devises)
- WAP — Wireless Application Protocol, for simplified browsing with cell phones and other related devices
- PDA — Personal Digital Assistants, Handheld computer
- E-mail — On computers, cell phones, PDAs
- SMS — Short Message Service, Messages on cell phones
- MMS — Multi Media Messaging Service, audio/video/text on cell phones
- Voice — On telephones
- Street panels — Outdoor displays

Each channel requires a different technical and content approach. Table 3 shows the results from end-user investigations in the APNEE projects regarding dissemination services.

Table 3 Results from end-user investigations regarding dissemination services.

Internet	Considered vital as the service that has all necessary facts and completeness. Backs all the other services.
WAP	Probably a solution that will not be much used in the future. However still good for some pull uses when people are on the move.
PDA	Difficult to conclude. Probably not interesting for the general public, might be interesting for expert users in the future.[10]
E-mail	Positive response from users, recommended basic service since it is also cheap to make.
SMS	The overall most preferred solutions for the public.
MMS	Interesting new service, but can not beat the easy to use SMS when SMS in fact can include all necessary facts.
Voice	Maybe outdated, yet of value for parts of the population; depends on culture
Street panels	Uncertain effect, depends on local habits

An overall conclusion was that:

- Internet pages are the preferred pull service, and are considered vital, especially in combination with SMS.
- SMS is the preferred Push service.

[10] It should be noted that this finding is more than 4 years old, this meaning that the percentage of use for PDAs and mobile computers has increased dramatically in the last years, thus suggesting that APNEE like services would be of interest as innovative content.

Part 2 Recommendations

This part of the report covers specific recommendations for the further development of the ozone web as shown in **Error! Reference source not found.**. This web solution was established in June 2006 and currently covers ozone from stations all over Europe. The main content is an advanced map interface for viewing current measurements from stations across Europe, different graphical and table comparison functions from the current and the previous week's data and important textual information about ozone, regulations, health effects, actions for citizens etc.

EEA air quality web – not just ozone

It is much needed that EEA takes on a role to coordinate both the further development of good national air quality dissemination solutions, as well as providing a European air quality web solution covering all types of local air pollutant compounds. This is the basis for the further recommendation in this report.

This is needed due to the lack of solutions in many countries, lack of coordination and knowledge sharing among those running solutions, and thereby the lack of utilising the potential contribution of Information Dissemination and Presentation solution as integrated parts of achieving the goals of improved air quality for all Europeans.

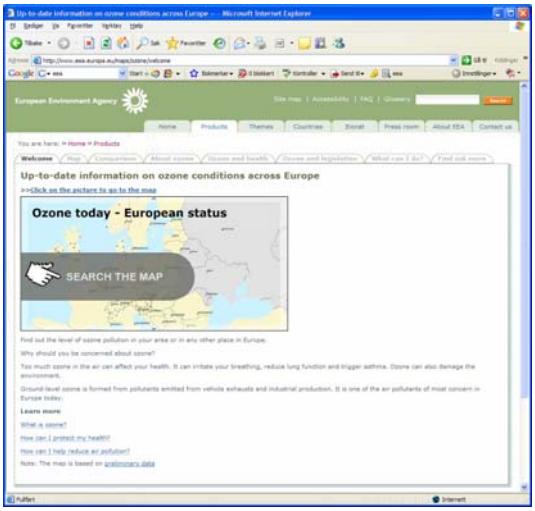

Figure 6 The current EEA ozone web

Assumptions – critical success factors

The basis for the recommendations given in this chapter is the fact that countries will provide the data the EEA needs since it will be seen as a positive contribution also for the national data providers. How this is done is addressed several places in the following chapters.

It is further assumed (based on the experience of AirBase) that the EEA solution in theory can get all kinds of AQ compounds and legally can keep the data in a central database on behalf of the data provider. It is further assumed that each data provider gives accept for the EEA to use the data for public purposes for any time period set by the data provider, e.g. they might allow EEA to show historical statistical data years back, while other data providers only allow for data being a few months old before deletion is required. This assumption results from the existing legal framework concerning public access to environmental information, and from the requirements of the Aarhus Clearinghouse for Environmental Democracy (http://aarhusclearinghouse.unece.org/)

It is also assumed that EEA will coordinate all reporting tools on closed expert pages (if established), as suggested in chapter 12, with other relevant systems for air quality data like Airbase and EMEP.

8. Development stages of AQ information dissemination solutions

For both national and international solutions like the EEA ozone web, it is important to reflect on the goal of the solutions. It is very important to keep the purpose of the Information Dissemination and Presentation (IDP) Solutions high on the agenda when developing and evaluating such solutions. There seem to be four likely phases that such solutions go trough:

1. IDP with correct AQ status and forecasts
2. IDP so that people use the information
3. IDP with the purpose of reducing health impacts
4. IDP to reduce pollution episodes

By evaluating different solutions it seems that most of the currently existing solutions, at least those that have existed for some years, have started with number 1 and are on their way to number 4. Newer solutions can jump more direct into the higher levels, yet accumulated experience suggests that phases 3 and 4 can run in parallel.

8.1. IDP - AQ status and forecasts

This is typically the situation when a scientific institution, national or local authority wants to inform the public about what the air quality facts are. The solutions is viewed as a new information source and many times provide important information previously not easy available. Therefore it is seen as a major step in the right direction, which it often obviously is. However the solution is typically made from the angle of the presenter, often being persons with high level of knowledge of air quality. So the solutions typically become scientifically correct, but not very easy to use for general public. In addition, and in many cases, authorities do not like to provide AQ information on an hourly basis, and they bypass the mandates of the related directives by publishing just minimum and maximum concentration values per pollutant (and or per monitoring site). These practices should be cancelled via proper technical guidelines and directive implementation mandates to all EU countries, issues by the EEA.

8.2. IDP so that people use the information

The next level is where the developers/owners of the solution realise that having a correct (as they believe) presentation of data and facts is not necessarily what ensures a wide use by all the potential end-users. This is where typically end-user tests with questionnaires, usability lab testing etc are used. The result is a new structure of the content, new use of headings with more intuitive language for non-experts and easier functionalities with less numbers and concentrations but where status and forecasts, if any, are visualised with symbols and colours.

8.3. IDP with the purpose of reducing health impacts

When level 2 is completed, the solution is actually working well as an information system for air quality. If the goal is to ensure easy access to all data and facts, the goal is reached. But what if one sets a higher goal? What if such information systems can actually reduce health impacts? Knowing what hit you, and reading about the damage is one thing, but

can information systems where one is giving live data and even forecasts actually reduce number of people being exposed to unhealthy levels of air pollution?

This level in development is only addressed to a limited extent in current solutions, at least in a systematic way. The questions from such an angle are:

- When must the receivers retrieve information in order to avoid exposure?
- How must they receive it in order to utilise it?
- What kind of information must they receive in order to be able to act?

The answers to these questions are simply:

- **When must the receivers retrieve information in order to avoid exposure?**
  Well enough in advance in order to change plans. Typically the day before episodes happen is very good. At the start of episodes is also good if forecasting is not possible.

- **How must they receive it in order to utilise it?**
  Basically delivered to them. Directly trough e-mal, SMS/MMS in combination with Internet for further details. Indirectly through media channels like TV, Radio and newspapers, again with links to Internet for details. So combining push with pull is important.

- **What kind of information must they receive in order to be able to act?**
  The clue for getting actions is that the easier it is to avoid exposure the easier it is for the receivers to change plans. If the message is that "Tomorrow will be bad in all of Oslo" for instance, most people cannot do much. The worst affected persons with lung diseases can however adjust medication or stay at home.

  If the message is that *"It will be bad in the eastern part of Oslo, and from 14:00 till 18:00, but rest of the day pretty good"*, the receivers can both adjust their plans for where and when to be during the day. This makes the potential for avoiding exposure far greater.

This might sound easy, however it requires:

- Advanced modelling and forecasting system with sufficient details for geographical and hourly differences within a city/area.
- Production of forecast messages by professional staff – they communicate with the receivers day by day and adjust messages accordingly – city/area specific staff that know how to communicate with their citizens
- SMS/e-mail solutions in combination with the Internet solutions
- Good dissemination of the messages through different media channels.

This is currently only in place for a few sites in Europe, like those with the most advanced solutions such as Paris and Oslo. However, the web solutions in these two cities are not really tuned for this goal. The forecasting and SMS/e-mail solutions are merely added on to the Internet solution. The tuning of the complete system for maximum reduction of health impacts as the goal, has not taken place yet. What about giving free SMS/MMS as health care to sensitive people?

8.4. IDP to reduce pollution episodes

The forth and highest level is where one is planning to actually try that the Information Dissemination and Presentation solutions directly, not only indirectly, but really directly,

has a role in reducing episodes of air pollution. The regulations in Europe, which is based on WHO approaches, has two main elements; concentration limits and number of days/hours that are allowed above these limits during a year. In addition there are levels for acceptable yearly averages. It is likely that both the limits and number of hours/days during a year will be reduced as new evidence of health effects from lower and lower doses becomes current knowledge and accepted.

A city/area has to take action if the number of days/hours is above the allowed number of exceedences. Can advanced IDP solutions contribute to this?

Some episodes, like ozone episodes in Europe, are typically not possible to affect directly on a daily basis. However, avoiding high levels of other pollutants in the air on such days clearly has positive health implications. The sources to high levels of local air pollution are mainly traffic and in some countries heating during winter, resulting mostly in particulate matter of various sizes and nitrogen oxides. In some countries CO, Hydrocarbons and Sulphur dioxide is also a local problem.

So if we could reduce the local sources explicit on days with bad meteorological conditions one could actually reduce the number of pollution episodes and/or the strength of such episodes. Resulting in improved health quality and possible reduce the needs for costly actions to keep number of episodes below allowed numbers.

8.4.1. Opens for new legal and economic instruments

The general problem with legal regulations and economic incentives is that they tend to be too general and viewed as extra tax for government income. IDP solutions open for a completely new approach to this in relation to reducing pollution episodes.

The idea is that one has a set of legal regulation and economic instruments that are triggered based on forecasts and are possible due to active use of advanced IDP solutions.

The technological development in general ensures that we are getting closer to monitoring all traffic, and even for individual cars, where they drive and their emissions. We have payment schemes for cars entering many cities already across Europe. We have full records of car types combined with license plates.

Example of episode driven system
Let us suppose that in a major European city the forecasts tells us about levels of air pollution above the limit values for the next two days, followed by rain and wind terminating the episode.

The day before one can issue through all the information channels, + using cell broadcasting where all mobile phones in an area gets a push SMS informing about:

> *Tomorrow and the day after, there will be a episode driven situation for air pollution. All cars entering the city will pay 10 times normal price. All public transport, which will run with double capacity, will be free of charge.*

Or

> *Tomorrow and the day after, there will be a episode driven situation for air pollution. All cars entering the city will be charged based on their emissions and length of travel within the city. Minimum charge 10 Euros. Bill sent by mail. All public transport, which will run with double capacity, will be free of charge.*

Or

Tomorrow and the day after, there will be a episode driven situation for air pollution. All cars with uneven last digit will be fined 100 Euros if entering the city. All public transport, which will run with double capacity, will be free of charge.

At the same time, all subscribed users in the IDP will get an e-mail/SMS with tuned information on public transport close to their normal route of transport.

All income from these days goes to ensuring extra public transport capacity for such days.

These kinds of solutions are partly implemented/tried in some cities, but not fully combined with all the new information one is getting from traffic, and at least not with the effect of combining them with really advanced IDP solutions. This needs to be studied and tested over the years to come.

An additional and very important economic incentive is related to health costs that may be levered by proper AQ information services[11]

8.5. Role for the EEA web

Given the likely development of Information Dissemination and Presentation solutions on the national level as described above, the EEA web solution must take this into account. The difficult fact is that the situation in Europe, as described in chapter 4, shows that the situation in different countries range from no solutions at all to solutions that are likely soon to be at level 3. This difference is probably just going to widen further if no coordinated action is taken.

This situation in fact gives the EEA an opportunity to have an active role in ensuring that all countries, and major cities/areas within all countries, at least get national solutions on level 1-2. Furthermore it opens for the possibility that the EEA can provide core functionalities that the individual countries do not need to make, since those functionalities can be provided by EEA. Suggestions in this regard are given in the following chapters.

[11] http://www.sussex-air.net/pdf_presentations/Sussex-air_BLF_airALERT%20-Brighton%20Jan%202007.pdf

9. Recommended role and profile

9.1. The EEA air quality web

Like all international institutions, the EEA has a challenge when starting to provide solutions that are partly or fully covering the same areas as national or local solutions in different countries. The important question is how the EEA air quality web solution can be viewed as an added resource for all countries and cities/areas?

There are some basic and important policy issues that EEA must make clear towards all countries and cities/area managers:

The EEA air quality web should:

1. Be a European resource that adds naturally to national and local solutions, not a competition
2. Extend information and presentation services by supplementing what exists nationally with additional functionalities and services
3. Contribute actively through the technical solutions and data transfers policies to easier and more reliable data reporting in Europe
4. Provide all interested parties with a free basic IDP solution of air quality for their country city/area
5. Facilitate knowledge sharing and competence building among the different owners and operators of IDP solutions in Europe and with other international relevant resources

By stating this policy loud and clear, the platform for success is established.

In order to achieve the policy goals outlined above, it is important that actions by EEA are always viewed as building on this policy. It is basically about creating trust and a working relationship with national owners and providers of IDP solutions so that EEA can be viewed by everybody as an important resource to achieve better information and presentation of air quality data and facts in Europe.

The core element for success is tuning the web solution with its functions so that goals 1 and 2 are understood and approved through the actual solution run by EEA. This is covered in chapters 10 and 12.

The third point in the policy list is covered in a separate report by NILU as part of the institute's responsibilities under the ETC/ACC for 2006.

The forth policy goal is covered in chapter 11.

The fifth goal element is to take practical steps and initiatives to involve and ensure the exchanges of know-how between the various interested parties. This is covered in chapter 13 and in 9.2 for international relations

9.2. EEA AQ web in relation to other international solutions

Point number 5 in the policy list above is really important. When evaluating end-user needs over the last years in various countries in Europe, America and Asia, the results are surprisingly similar. Furthermore the Internet technique is global. What varies mostly is

culture, trust in governmental information and use of new distribution channels like SMS/MMS etc.

The potential to learn form end-user tests of other solutions, experiences etc. is not even close to being utilised. There is no logical body to do this today and solutions are made completely independent of each other, except for a few relevant EU research projects. There are a few international providers of commercial software for Information Dissemination and Presentation solution, but they are not involved in the policy and research behind such solutions in any great scale. Of the European national providers it is mainly NILU that has developed an international version based on the experience with the national Norwegian solutions. They have currently installed solutions in South Africa, Vietnam, Israel and the complete new solution for Cyprus utilises features not even established in Norway yet.

AirNOW in USA, as well as the Japanese solutions for Tokyo is also worth communicating with in other to improve the European solutions.

In facilitating and coordinating knowledge and experience on the international arenas EEA can have an active role that is currently lacking.

Thus, it would be very beneficial if the EEA could organise a meeting on environmental-air quality information services (ID&P solutions), inviting the key organisations, players and experts from Europe and abroad, in collaboration with WHO and UNEP.

10. Recommended content, data and functional extensions

In order to achieve the policy goals outlined in chapter 9, it is important to recognise the possibilities that arise from running a European wide solution:

These include the possibilities to:

- compare country status and forecasts on a daily basis
- compare single values in same legends/classifications
- give comparable compliance views of EU-regulations
- provide with comparable abatement measures in Europe on cases of episodes
- give European trends on pollution levels of different kinds
- explain the basic differences and AQ profiles within EU countries and regions (i.e. different background concentrations, etc)
- compare country developments in pollution levels
- act as the one stop-shop for data for people travelling in Europe
- show cross-national transport of pollutants
- compare country emissions per polluter category
- link local AQ information on country level with information on other air pollutants e.g. climate change compounds

These are unique features that cannot be done in national solutions. It is therefore natural to concentrate on them when defining the specific content of the EEA AQ web solution.

National solutions for dissemination of environmental information in general seldom have sufficient funding. This means that trade-offs often have to be made in order to ensure well working solutions, for instant on GIS interfaces. It is also so that many nice to have solutions are not really worth the costs on a national level, for instance multi language solutions. This situation opens for well-received modules in the EEA web where functionalities are seen by all as excellent add-ons to national solutions.

The typical features in this regard are:

- Advanced GIS/map functionality
- multi language presentation of facts and data
- Personalised pages
- Scientific factual library
- SMS/MMS/e-mail services

This type of features might be possible in some countries, but for many they are not possible within the allocated budget.

The EEA should concentrate on providing a solution that focuses on what is not possible on national level partly due to the fact that the EEA web will be the only one with live data from many countries across Europe. Furthermore concentrate on adding features to national solutions by providing modules that easily add on to what is done in national solutions.

At the ITC level, the EEA should develop these solutions as open source components, and tailor them for EEA needs, while also providing sufficient documentation and technical guidelines for those countries wishing to use some of these components for providing related functionalities to national solutions. On this basis, it is suggested that the EEA formulates a working group on this issues, in relation to the existing ICT initiatives within the agency, in order to come up with a study on the technologies and the

architecture of possible solutions. This will very well accompany the EU initiatives of e-governance, and will provide with the benefits of economy of scale plus a basic development frame for each national solution. The disseminating of the ICT solution can use the model of the DEM tool of the EEA.

10.1. Recommendations to extend to new compounds

It is recommended that the EEA web solution is extended in two steps:

1. 2007/2008: Particulate Matter PM_{10} and $PM_{2,5}$, as well as Nitrogen oxides (NO_X, NO_2 and NO)
2. 2009/2010: Additional compounds to be included*

*Note: The additional compounds to be covered, should be evaluated in 2009 based on the status across Europe of the different compounds, the monitoring and reporting requirements in the daughter directives and e.g. the new vehicle monitoring demands, EURO 5.

The data shall if possible be provided on an hourly basis from at least all the official EU stations in the countries through the data retrieval system developed. Funding and support to countries to set up necessary transfer procedures and solutions will be necessary in many cases.

10.2. Recommendations to include forecasting forwarding functions

The clear conclusion from all studies of end-user value is that forecasts are the single most valuable function for the end-users. In Europe there are solutions for regional forecasting building on meteorological conditions and transportation of polluted air masses across Europe, as well as detailed local scale forecasts.

The EEA web should cover both these forecasting methods in a two-step approach:

1. 2007/2008: Local forecast common display
2. 2009/2010: Regional forecasts of Particulate Matter

As described previously in this report, the detailed local forecasts, where they exist, are the absolutely most valuable information providing such solutions aim at actually reducing impacts, or even better, be part of management solutions to reduce episodes. Everything that can be done to enhance the making of such forecasts in more cities, as well as improving their quality, is therefore of great value.

The idea here is that EEA receives forecasts for a city or area from the national providers in the form of a general level for the next day together with text that explains more details (like where in the city/area there will be highest levels, at what time during the day etc). EEA can utilise the forecasts graphically, in tables or in the map solution, thereby providing a European view of forecasted air quality for the next day. It obviously requires a minimum of countries to take part in order to launch the solution, but the hope is that such a display will motivate more countries/cities/areas to provide forecasts solutions.

The second step is for ozone, which is of general value to many citizens since ozone episodes are regional as opposed to local traffic related pollutants like particulate matter and nitrogen oxides. However, regional forecasting of particulate matter can only be of background interest and more scientific interest since local modelling systems are needed in order to give end-user value of where end when high levels will occur. SO_2 is of somewhat medium value and should probably be prioritised before making regional forecasting for particulate matter.

10.3. Recommendations to develop multi language solution

All across Europe it is a challenge to inform all citizens in health related matters due to the mixture of languages and many individuals moving between countries. Furthermore, travelling of Europeans for the purpose of holidays and/or work is growing rapidly. Therefore the needs for multi lingual solutions of health related information is needed in all European languages, but also in fact in many other national languages.

The EEA web should cover both these language needs in a two-step approach:

1. 2007/2008: Full functionalities in all European languages
2. 2009/2010: Full functionalities in all major international languages

This will ensure that national web solutions can link their solutions to the EEA web solution for looking at data in other languages. This saves huge resources on national level and ensures that their obligation to make information available in several languages are met in an easy and cost efficient way across Europe.

10.4. Recommendations to develop compliance module

Local air quality is, as previously covered in this report, a serious health problem in Europe today and is likely to increase in the decades to come if current policies are not strengthened. The strong increase in climate change debate and policies might in fact put the local air pollution more in the shadow. It is therefore important to strengthen the information part that relates to the formal legal requirements of the EU regulations. One such tool is to provide media, politicians, managers, scientists and NGOs with easy to use compliance views.

The EEA web should cover compliance views in a two-step approach:

1. 2007/2008: Compliance status per year for all countries in relation to EU regulations in different comparable views.
2. 2009/2010: Developments in compliance country by country in different easy to use views.

The point is to put pressure on those lagging behind and with negative trends, as well as use those with positive developments to show others what is possible and give examples on how positive development is achieved.

Furthermore this enhances the interest in the Information Dissemination and Presentation solution at EEA as well as the national editions, and thereby enhances the chance of daily use to avoid exposure by more citizens.

10.5. Recommendations to extend the GIS solution

The current ozone web has a rather advanced GIS solution already established and it is important to keep developing this solution. The natural extension of the solution comes with the extensions to new data, multi lingual solutions and forecasting data. It is further recommended to do a new detailed usability test of the solutions since it might still be rather complicated to use. There are also possibilities to look closely at some of the national map features used in other countries where for instance more information pops up by hovering or mouse clicking and see if any of these functionalities are suitable for the EEA web as well.

The stepwise construction of the GIS solution will have to follow the development of the other extensions.

10.6. Recommendations to extend comparison solutions

The comparison solutions of the current ozone web is a very important element fitting very well with the suggested policy goals for the extended AQ web solution. This might not need much further technical development except for inclusion of the new compounds and also extension for the compliance comparison suggested.

10.7. Summary of recommendations on content, data and functional extensions

The stepwise approach as described above is chosen deliberately to facilitate the natural combination of extensions where the new features actually have synergistic effects. The multi language features combined with the presentation of all forecasts as well as new maps solutions enhance all national forecasts to new audiences.

In prioritising the extension, weight has been given to the policy goals for the EEA web solution as earlier outlined. Doing so results in the following suggested stepwise approach for the five extensions covered:

Step one, 2007/2008:

1. Local forecast common display
2. Compliance status per year for all countries in relation to EU regulations in different comparable views.
3. New data: Particulate Matter PM_{10} and $PM_{2,5}$, as well as nitrogen oxides (NO_X, NO_2 and NO)
4. Full functionalities in all European languages

Step two: 2009/2010:

1. Developments in compliance country by country in different easy to use views.
2. Full functionalities in all major international languages
3. New compounds
4. Regional forecasts of Particulate Matter

In total the development takes four more years, but this is natural given the complexity of the task and the need for in-depth detailed discussions and end-user tests many times during this process.

11. Recommended tools to help countries with no or poor solutions

All countries should have Information Dissemination and Presentation solutions for air quality for their monitoring networks. The solutions should as a minimum give live data from monitoring stations and factual support information. Most European countries do not have solutions on national level, but there are many individual regional or city specific solutions across Europe (see details in chapter 4).

The tricky part of establishing, operating and developing such solutions is not the actual web displays. The difficult part is to ensure a steady dataflow to the database necessary and implementation of all the extractions, quality checks of the data and program correct calculations needed to show data in the various visualisations. Problems can, and will occur in one or more stations/instruments during a year and the solution shall still continue to work and not display errors. It is fundamental for such systems that the users, being citizens, media etc can trust the data that are presented.

Given the fact that it is recommended that the EEA web is extended to cover all basic local air pollutants, and that the EEA web therefore must ensure all the quality checks, calculations and correct data presentations independently of what is happening in the dataflow, it is rather easy to provide countries with a basic display of their data.
It is important, though not to interfere with the right of each country to materialise individually ID&P solutions. Thus, the EEA should also provide with a basic, freely available, set of ITC tools, to be implemented, localised and tailored to country needs (or even to city needs). The latter (city oriented systems) may also provide with some "political" advantages, as they do not require the consensus of a national authority, but they will result as an initiative of a local authority. The EEA should play an active role in these procedures.

The benefit from such a solution for EEA is that it will encourage countries to both monitor and/or report all their data to the EEA. For the country/area/city it enhances the value of their monitoring network and ensures compliance with information requirements in the EU directives. For citizens it gives access to information needed for health protection and it puts further pressure on the country/area/city to ensure both monitoring and actions to reduce pollution where necessary.

11.1. Recommendations for EEA to develop web solution for countries/areas/cities

All data in the EEA web are linked to a data provider. For each provider, different metadata can be attached, for instance use of an EEA local display solution. For all stations geo-references and different metadata are provided so this is also used for the local web solution. Furthermore the data information concepts used for functions used for expert pages, see chapter 12, can be utilised.

The recommendation is that EEA makes a standardised basic web display of data from monitoring networks. It should contain:

- Latest status (colour symbols) for all stations (both on map and in tables)
- Forecast information (if it exists)
- Simple statistical view of the data
- Simple comparison of the data between the stations
- Textual information about air pollution

- Report module
- Links module

Common for all countries/areas/cities using the solution:

- Maps are taken from the GIS solution in the central EEA web
- Comparison solution is taken from the GIS solution in the central EEA web
- Legends will follow the EU regulation and be the same as in the EEA web
- Colours will be the same as in the EEA web
- Symbols will be the same as in the EEA web
- English as delivered language, module for adding as many languages the operators like. All fixed texts can be set in any language

Specific or all countries/areas/cities using the solution:

- Any additional language in addition to English must be specified by the operators. Easy interface for doing so is to be provided.
- Factual text, basic text provided, full editing functions, new items possible to add, existing to delete
- Reports can be added into the report module with title, description, date etc.
- Logos can be added in predefined locations and size on the site
- Contact information can be added in predefined locations and size on the site
- Layout skin, options to choose from several should be provided
- Provider sets allowed time span for data extraction (backwards)

Such a solution should be made with a tailored administration interface and not use standard interfaces. Testing shows the clear benefits from tailoring such interfaces since there are so many specific demands in air quality data dissemination solutions. Tailored solutions have far better chances to be used, thereby ensuring the success of the solution over time.

11.2. Recommended process for web solution for countries/areas/cities

Like for most web solutions, the success is really demonstrated after some time, both by how the operators are able to maintain it and also how many end-users are using it out of the assumed likely end-user potential.

For the suggested solution, which EEA provides as a free offer to countries/areas/cities, it is important that those that currently don't have such solutions, or are struggling with the one they have, intuitively react positively and decide to move into the EEA solution.

Therefore it would be very good if this solution utilises some of these countries/areas/cities as a reference group from the beginning of planning this solution. When launched it should have several operators already using it from day one. It is therefore important to pick countries/areas/cities from different parts of Europe to show the value for many countries/areas/cities across Europe.

In addition it would be advisable to involve those national solutions where there are sub sections for areas/cities within the solution and draw on their experience on how to ensure good functionality on that level.

This module is of course voluntary and many countries will continue to run their own national solutions, and still provide EEA with all required data.

12. Recommended expert pages

One important “sales argument” towards data providers in order to get them to send data to the EEA web is the potential for free functions they can access on closed expert pages. This has been discussed during the development of the current ozone-web solution, but it becomes more important to address if the EEA web shall extend as described in chapter 10.

The standard procedure for data processing following the acquisition from the station/instrument of air quality data is

1. Storing of raw data
2. Validating of individual data
3. Approval of datasets
4. International reporting

There are different ways of doing this, but the most common is to use quality level flags as integrated with the data itself. This means that all hourly values (some compounds have other standard time intervals) have a flag attached to them and that is changed as the steps 1 through 4 are followed. A combination of quality level flags and separate databases and extra flags is also used in some countries. In other countries separate databases/tables for the different datasets are used.

By adopting a strict regime on all data that is retrieved by the EEA web where one operate with 4 quality level flags in accordance with the list above, great possibilities arise. This is the basis for the solutions recommended in the rest of this chapter.

It is assumed that the expert pages are built with user access to administration in which the various users only gets access to their own data and/or data opened by other providers for free use. It is further assumed that the expert pages can have modules for other persons/organisations than the data providers where data are aggregated and presented in other ways for other needs. In this chapter, only modules to be made available solely to data providers are covered. It is very important that there is a strict control with this so that all data providers will feel 100% safe that they have full control of their data and the distribution of them, also when all data are submitted hourly to the EEA web.

It is recommended that these suggested modules for data providers are made available at the end of step one, being end of 2008, since they fit well with the extensions proposed in step 1.

12.1. Recommended QA/QC module for data providers

This module is suggested to be a service module for operators of monitoring networks. It is planned used for the validation and approval of data and time series. Trough this module the operator can, on time intervals set by national and international procedures, perform the validation (individual or from a certain time to a time of hourly values can be set to valid/non-valid) and electronically sign the process. This then automatically changes the data quality flag to the next level. Then the same operator or another person with that clearance, can approve time series. This is then set to be done week-by-week or month-by-month for each compound per station, resulting in next quality flag. When this is done the time series is approved and thereby becomes an official time series for that station. This process is also then electronically signed and all these steps are logged with details of operator etc. The data will then be used as official data nationally or internationally. The original concentration values are always kept, it is just the change in

flags that is stored. This allows for reproduction and extraction of data from different stages in the approval process.

An important aspect to keep in mind is that the compliance module suggested for the public pages will only use data with flag that certifies that the data are approved. Therefore either this module must be in place or the data providers must have done this locally and submitted the approved time-series in order for their data to show in this module. This is due to the fact that legal and management actions can be taken upon the compliance views and thereby can only use officially approved data.

The solution will encourage monthly validation and approval procedures and thereby opens for European official data records much faster than today where up to 18 months of delay is often the case.

12.2. Recommended international reporting module for data providers

This module builds on result of the QA/QC module or received data from the data providers with the quality level flag indicating that the time series have been approved. All countries/data providers have requirements for reporting to EC, Airbase, EMEP etc. This is a challenging task due to the complexity of reporting format and lack of standardisation. It is likely that it will take many years before common systems in this regard are developed and implemented.

EEA can in this respect take on a role to provide all data providers of local air quality data a one-stop solution that ensures that all data are reported correctly and within deadlines. Furthermore this shortens the time lag currently in e.g. reporting to Airbase.

This module basically structures and calculates the data in accordance with the receivers' needs and extracts the necessary metadata from the database. Required information not in the EEA solution as standard will be displayed and manually entered by the operator. Information valuable for several years will be stored for the next years to use to speed up reporting as years go by.

In addition the operator will be reminded by e-mail of deadlines for reporting in fixed intervals each year. Full log of the reporting and everything to be electronically signed must be implemented.

In this way EEA takes on to always ensure correct reporting to all compulsory organisations in Europe for all national AQ data. Changes in the required information/data can then be fixed in one place.

The benefit for EEA is a strong relationship and dependency between the countries to deliver data in order to get access to this valuable solution. For the data providers the benefit in saved time and hassle is obvious.

Again the use of the solution is voluntary, and data providers not using the other expert module can still use this module as long as they submit data with the necessary quality flag.

12.3. Recommended data export module for data providers

EEA will through the outlined solution keep a database of all the national data. This is a service for many countries not having good national databases themselves. From the EEA

database there must be an easy to use export module where the data-providers can choose which datasets are to be exported and if it should be raw data, validated data or approved data.

The export module should also allow utilisation of the aggregation functions in the EEA web and thereby exporting all standard averages in stead of hourly values, thereby saving processing time for the operators.

The export formats should be different options for easy importing into different programs by the operator. It should further be an easy data exchange format so it stimulates third party providers to offer extended services/programs like data-analysis and reporting functions.

13. Recommended consultation and management principles

From the recommendations previously given in this part of the report, it is clear that the trust of the national data providers and their view that the EEA web is valuable directly for them in their management obligations as well as the EEA being instrumental for improving air quality management in Europe is necessary.

Such trust and role is much easier to establish if the community of data providers, solution developers, solution owners, national and local air quality managers, air quality scientists and the other formal air quality bodies, especially ETC/ACC is actively involved and feels ownership to the solution. With the ozone-web EEA has pointed out a course where the agency wants to take a more proactive role in this matter. The success of this depends heavily on the agency's ability to create this trust and ownership in the years to come.

13.1. Recommended consultation process

Based on this it is strongly recommended that EEA establishes a consultation process with key stakeholders across Europe in the next four years for development of the extended web-solution. This should be done as workshops two times a year, involving 10-15 selected individuals across Europe representing different roles and responsibilities.

In addition a wider consultation where mock-up of suggested new solution, one in each of the two next development steps suggested previously, is made available for comments from all countries.

For the expert pages a separate process with mock-ups is checked with all data-providers.

13.2. Recommended management principles

It is further strongly recommended that the EEA establish a management system for the EEA AQ web where one has a steering body as well as a editorial board with representatives of key experts across Europe. Again strong ties to ETC/ACC are necessary. It goes without saying that all persons approved for position in either the steering body or editorial board must have a positive view of the EEA AQ web and agree on the basic goals of the solution.

With such a management structure, in addition to staff ensuring the daily operation, the EEA AQ web can become a really strong valuable tool for the further improvement of air quality in Europe.

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Annex A:
List of European air quality web solutions

The following is a list of existing web solutions with **on-line data** in European countries (national solutions) or cities/regions. The list is not necessarily complete, but gives a pretty good overview of what exists in Europe per February 2007.

No	Country	AQ web solution
1	**Albania**	Nothing found
2	**Andorra**	Nothing found
3	**Austria** National solutions: 0 Regional/local solutions: 4	***Regional/local solutions:*** *Burgenland:* http://www.luft-bgld.at/ *Steiermark:* http://www.umwelt.steiermark.at/ *Vorarlburg:* http://www.vorarlberg-luft.at/ *Vienna:* http://www.wien.gv.at/
4	**Belarus**	Nothing found
5	**Belgium** National solutions: 2 Regional/local solutions: 1	***National solutions:*** *Belgium Interregional Cell for the Environment:* www.irceline.be *IBGE-BIM/ Brussels Environment:* http://www.ibgebim.be/ ***Regional/local solution:*** *Vlaanderen:* http://www.luchtkwaliteit.be/technopolis
6	**Bosnia and Herzegovina** National solutions: 1 Regional/local solutions: 0	***National solution:*** http://www.fmzbih.co.ba/
7	**Bulgaria**	Nothing found
8	**Croatia**	Nothing found
9	**Cyprus** National solutions: 1 Regional/local solutions: 0	***National solution:*** *The Department of Labour Inspection:* http://www.airquality.dli.mlsi.gov.cy/
10	**Czech Republic** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Czech Hydrometeorological Institute:* http://www.chmi.cz
11	**Denmark** National solutions: 1 Regional/local solutions: 1	***National solution:*** *National Environmental Research Institute:* http://www.miljoe.kk.dk/ ***Regional/local solution:*** *Copenhagen:* http://www.miljoe.kk.dk/
12	**Estonia**	Nothing found

13	**Finland** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Finnish Meteorological Institute:* http://www.fmi.fi/
14	**France** National solutions: 1 Regional/local solutions: 20	***National solution:*** *The French Ministry for Ecology and Sustainable Development (38 monitoring networks):* http://www.prevair.org ***Regional/local solutions:*** *East: Caen, Alencon, Saint-lo, Lisieux:* http://www.air-com.asso.fr/ *Bourdeux and more:* http://www.airaq.asso.fr/ *Bretagne:* http://www.airbreizh.asso.fr *Alps:* http://www.airfobep.org/ *South – east coast: Perpignon, Montpellier, Nimes and more:* http://www.air-lr.asso.fr/ *Region of upper Normandy:* http://www.airnormand.asso.fr/ *Loire region:* http://www.airpl.org/ *Alsace region:* http://www.atmo-alsace.net/ *Picardie region:* http://www.atmo-picardie.com/ *Franche Comté:* http://www.arpam.asso.fr/ *Auvergne region:* http://www.atmoauvergne.asso.fr/ *Champagne-Ardenne region:* http://www.atmo-ca.asso.fr/ *Lorraine region:* http://www.atmolor.org/ *French region Nord Pas de Calais:* http://www.atmo-npdc.fr *Poitou-Charentes region:* http://www.atmo-poitou-charentes.org/ *Rhône-Alpes region:* http://www.atmo-rhonealpes.org/site/

		Bourgogne region: http://www.atmosfair-bourgogne.asso.fr/ *Region Centre:* http://www.ligair.fr/ *Midi-Pyrenees region:* http://www.oramip.org/html *Northern part of France:* http://www.esmeralda-web.fr *Paris region:* www.airparif.fr
15	**Germany** National solutions: 1 Regional/local solutions: 15	***National solution:*** *Federal Environmental Agency (FEA):* www.env-it.de ***Regional/local solutions:*** *Bavaria region:* http://www.bayern.de/lfu/lfu1 *Hamburg region:* http://www.hamburger-luft.de/ *Hessen:* http://www.hlug.de/ *Sachsen:* http://www.umwelt.sachsen.de/de/wu/umwelt *Reinland-Pfalz:* http://www.luft-rlp.de/aktuell/messwerte/ *Sachsen-Anhalt:* http://www.mu.sachsen-anhalt.de/start *Nordrheim-Westfalen:* http://www.lua.nrw.de/ *Land Brandenburg:* http://www.mluv.brandenburg.de *Schleswig-Holstein:* http://www.umwelt.schleswig-holstein.de *Saarland:* http://www.umweltserver.saarland.de/ *Niedersächsischen:* http://www.umwelt.niedersachsen.de *Region Thüringen:* http://www.tlug-jena.de/ *Baden-Württemberg:*

		http://www.um.baden-wuerttemberg.de *Berlin:* http://www.stadtentwicklung.berlin.de/ *Bremen:* http://www.umwelt.bremen.de
16	**Greece** National solutions: 0 Regional/local solutions: 2	***Regional/local solution:*** *Athens* http://www.minenv.gr/, http://www.airthess.gr
17	**Hungary** National solutions: 1 Regional/local solutions: 0	***National solution:*** http://www.kvvm.hu/
18	**Iceland** National solutions: 1 Regional/local solutions: 1	***National solution:*** *Environment and Food Agency of Iceland* http://www.ust.is/ ***Regional/local solution:*** *Reykjavik:* http://www.loft.rvk.is/
19	**Ireland**	Nothing found
20	**Italy** National solutions: 0 Regional/local solutions: 13	***Regional/local solutions:*** *Bolzano Alto Adige:* http://www.provincia.bz.it/agencia%2Dambiente/ *Lombardia:* http://www.arpalombardia.it *Emilia-Romagna:* http://www.arpa.emr.it/ *Marche:* http://www.arpa.marche.it/ *Toscana:* http://www.arpat.toscana.it/ *Veneto:* http://www.arpa.veneto.it/ *Abruzzo:* http://www.artaabruzzo.it/ *Friuli Venezia Guilia:* http://www.arpa.fvg.it/ *Valle d'Aosta:* http://www.arpa.vda.it/ *Umbria:* http://www.arpa.umbria.it/ *Trento:* http://www.provincia.tn.it/ *Piemonte:* http://www.sistemapiemonte.it/

		Torino: http://www.provincia.torino.it/
21	**Latvia**	Nothing found
22	**Liechtenstein**	Nothing found
23	**Lithuania**	Nothing found
24	**Luxembourg**	Nothing found
25	**The Former Yogoslavioc Republic of Macedonia**	Nothing found
26	**Malta**	Nothing found
27	**Moldova**	Nothing found
28	**Monaco**	Nothing found
29	**Netherlands** National solutions: 1 Regional/local solutions: 1	***National solution:*** *Landelijk Meetnet Luchtkwaliteit (LML):* http://www.lml.rivm.nl/ ***Regional/local solutions:*** *Rijnmond/Rotterdam:* http://www.dcmr.nl/
30	**Norway** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Norwegian Institute for Air Research* www.luftkvalitet.info
31	**Poland** National solutions: 0 Regional/local solutions: 13	***Regional/ local solutions:*** *Gdansk and Tczew:* http://www.armaag.gda.pl/ *Bialystok:* http://www.wios.bialystok.pl/ *Bydgoszcz:* http://www.wios.bydgoszcz.pl/ *Katowice:* http://www.katowica.pios.gov.pl/ *Kielce:* http://www.kielce.pios.gov.pl/ *Lodzi:* http://www.wios.lodz.pl/ *Olsztyn:* http://www.wios.olsztyn.pl/ *Opole:* http://www.opola.pios.gov.pl/ *Poznan:* http://www.poznan.pios.gov.pl/ *Rzeszowie:* http://www.wios.rzeszow.pl/ *Szczecin:* http://www.wios.szczecin.pl/

		Warsaw: http://www.wios.warszawa.pl/ *Zielonej Górze:* http://www.zgora.pios.gov.pl/
32	**Portugal** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Ministry of environment:* http://www.qualar.no
33	**Romania**	Nothing Found
34	**Russia**	Nothing Found
35	**San Marino**	Nothing Found
36	**Serbia and Montenegro** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Republic Hydrometorological service of Serbia:* http://www.hidmet.sr.gov.yu/
37	**Slovakia (Slovak Republic)** National solutions: 1 Regional/local solutions: 1	***National solution:*** *Slovenský hydrometeorologický ústav:* http://www.shmu.sk/ ***Regional/local solution:*** *Bratislava:* http://www.bratislava.sk/
38	**Slovenia** National solutions: 1 Regional/local solutions: 0	***National solution:*** *Ministry for Environment and Spatial Planning* *Environmental agency of the republic of Slovenia:* http://www.arso.gov.si
39	**Spain** National solutions: 0 Regional/local solutions: 2	***Regional/ local solutions:*** *Andalucia:* http://www.juntadeandalucia.es/ *Catalan:* http://www.gencat.net/
40	**Sweden** National solutions: 1 Regional/local solutions: 10	***National solution:*** *Swedish Environmental Research Institute:* www.ivl.se ***Regional/local solutions:*** *Stockholm:* http://www.slb.mf.stockholm.se/ *Gothenburg:* http://www.miljo.goteborg.se *Helsingborg:* http://www.helsingborg.se/ *Øresund:* http://www.oresundsluft.com/ *Jönköping:* http://www.jonkoping.se/ *Luleå:* http://www.lulea.se/ *Malmö:* http://www.malmo.se/

		Norrköping: http://www.indic-airviro.smhi.se/ *Umeå:* http://app01.app.umea.se/mlv/main *Västerås:* http://193.14.183.160/vasteras/API/index.html
41	**Switzerland** National solutions: 3 Regional/local solutions: 11	***National solutions:*** *Amt für Natur and Umvelt:* http://www.umwelt-gr.ch/ *Federal Office of Meteorology and Climatology MeteoSwiss:* http://www.meteoschweiz.ch/ *Federal Office for the Environment (FOEN):* http://www.umwelt-schweiz.ch ***Regional/local solutions:*** *Canton of Solothurn:* http://www.so.ch/ *Canton of Neuchâtel:* http://www.ne.ch/ *Geneva:* http://www.geneve.ch/ *Canton Aargau, Luzern, Nidwalden, Obwalde, Schwyz, Uri and Zug:* http://www.in-luft.ch/ *Canton Basel Landschaft:* http://www.baselland.ch/ *Canton of Bern:* http://www.be.ch/ *Region Bern:* http://www.meteotest.ch/ *Canton Jura:* http://www.jura.ch/ *Freiburg:* http://admin.fr.ch/ *City of Bern:* http://www.bern.ch/ *Zürich:* http://www.stadt-zuerich.ch/
42	**Turkey**	Nothing found
43	**Ukraine**	Nothing found
44	**United Kingdom** National	***National solution:***

	solutions: 1 Regional/local solutions: 8	*AEA Energy & Environment:* www.airquality.co.uk ***Regional/local solutions:*** *London:* http://londonair.org.uk/ *Heathrow area:* http://www.heathrowairwatch.org.uk *Hertfordshire and Bedfordshire:* http://www.hertsbedsair.org.uk *Kent and Medway:* http://www.kentair.org.uk *Leicester:* http://www.leicesterequal.co.uk *Manchester:* http://www.greatairmanchester.org.uk *Sussex:* http://www.sussex-air.net *Wales:* http://www.welshairquality.co.uk/
45	**Vatican City**	Nothing found

Annex B:
List of figures used

Annex C:
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