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State-of-the-Art in the Dissemination of AQ Information to the General Public

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Abstract

Air pollution is among the most significant and well studied concepts of environmental pressures. Basic aspects of air pollution and air pollutant identification were already discussed 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 , interpretation and communication of AQ information remains open, and needs to be addressed in an effective way, in order to design better pollution abatement strategies and AQ information services. Moreover, contemporary AQ information dissemination methods and tools can now make use of various telecommunication channels for pull and push service provision. These may include 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. In addition, location based services are also emerging in the field of personalised, quality of life services. Moreover, communication per se is not based solely on written or oral language forms, but makes use of graphical, symbolical and in more general terms multimedia language communication schemes, via properly designed multimedia environmental information content. The present paper provides information on the state-of-the art concerning people's perception and awareness of air quality information, and on AQ (and environmental, in general) information dissemination. The paper also draws conclusions concerning the design and the functions of AQ information services, thus providing valuable information to research institutes, authorities and companies working in the area of environmental information dissemination.

1. Introduction

Air Quality Information Services (AQIS) are not just a consequence of the implementation of the AQ legislation at European level, but they rather represent the first "drafts" of quality of life, personalised, electronic information services. Such services attempt to integrate the need for improved well being on a personal level with the understanding of environmental pressures and their consequences, especially at the urban scale. They also provide with valuable information concerning the way that the pattern of our everyday life is associated with exposure to, and consequences of, environmental pressures. It is becoming more and more clear that such pressures have different spatial scales (ranging from a neighbourhood to a regional problem), and multiple temporal scales (from the seconds of street canyon photochemistry to the hours of duration of a pollen episode, moving towards the days of duration of an ozone episode). The multiplicity of time and space related scales of environmental pressures calls for information services that are capable of addressing them; services that are also in the position to effectively operate within scale boundaries. On the other hand, many environmental problems are of multiple time and space scales simultaneously, air pollution being among the most prominent ones. Although this statement is strongly supported by scientific evidence, it has not become part of the human understanding concerning the characteristics of the environment that he/she lives in. Certain perceptions of environmental pressures and problems still dominate the way that people understand and interpret quality of life constituents like the quality of the atmospheric environment. The present paper discusses aspects of air quality information

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services, on the basis of a review of related projects and applications that was mainly compiled in the frame of the author's work concerning a report for the European Environment Agency's Ozoneweb system (Endregard et al., 2007). Use is also made of the results of a special session organized by the author in the frame of the ISESS 2007 conference (Karatzas, 2007), and by the work conducted in the frame of another Environfo2007 paper (Trausan-Matu et al.,2007).

2. Air quality information and its dissemination

Access to environmental information was one of the results in the implementation of laws for the protection of the environment. It was early recognized that well informed citizens in environmental issues can support the formulation and application of practises for the protection of the environment and the support of sustainable development (a development that optimises the usage of natural resources on the basis of environmental criteria for tomorrow). Yet, what was lacking (and it still is), is a model for effective communicating of environmental information to the public. This type of model – guidelines, started to rise within the related legal framework, that, in its turn, tried to incorporate in the best way the scientific knowledge concerning the impacts of AQ to human health and the environment, and introduced in our everyday vocabulary terms like assessment, limit values, target values, concentration and many others.
Thus, the first EU legislation concerning air quality information availability was Dir. 82/459 later replaced by Decision 97/101. which stated that E.I. should be made accessible to the public via an information system set up by the European Environment Agency (EEA). This decision led the EEA to establish the European air quality information system Airbase. Airbase provided with a backbone for information communication but, most importantly, with a platform for the development of the idea that EI should be made available to the public via automatically operated communication channels.

The major change came with Directive on Ambient Air Quality Assessment and Management (96/62/EC), that required for the development of action plans concerning zones within which concentrations of pollutants in ambient air exceed limit values. These limit values were established by new (Daughter) Directives, that replaced old ones . It is worth noting that within these Daughter Directives, the use of computer-network services is mentioned in order to provide the public with the appropriate air quality information, which should be up-to-date and should be routinely made available to the public (Karatzas and Moussiopoulos, 2000).

Yet, it difficult to come up with a harmonised, and homogeneous (regardless of time, space and pollutants) way to briefly and accurately describe AQ and communicate related information, due to the complexity of the air pollution problem per se and the variations in the way that limit values and alert thresholds are defined and calculated. Some examples on the basis of "popular" pollutants follow:

- Particulate matter. This is a category of pollutants, which is further classified on the basis of their mean aerodynamic diameter and of their physical state (liquid, solid, mixed). The most well known is is PM10, i.e. particulate matter of solid state and of mean diameter in the order of 10 μm. This is a pollutant that is directly emitted my combustion processes and by traffic, while in some regions is also produced as the result of mechanical degradation of the road surface and of winter tires. The criterion applied for assessment is the mean 24h averaged concentration, and the limit value used equals $50\mu g/m^3$, not to be exceeded more than 7 times per calendar year. Another criterion exists, concerning the mean annual value, which is $20\mu g/m^3$ not to be exceeded.
- Nitrogen dioxide (NO_2). This is a pollutant that results from combustion and traffic, and has a strong photochemical profile, i.e. has the tendency to react with other pollutants like O_3 in the presence of sunlight and supported by the catalytic effect of other polluters. The criterion applied for assessment is the 1 hour averaged concentration, and the limit value is $200\mu g/m^3$ not to be exceeded more than 18 times per calendar year. Another limit value is applied for the mean annual

concentration ($40\mu g/m^3$, not to be exceeded), and another for the protection of ecosystems (mean annual concentration of $30\mu g/m^3$, not to be exceeded)

- Ozone (O_3): This is a pollutant that is not directly emitted but produced in the atmosphere, as the result of the change in the chemical balance of the atmospheric air, due to the existence of other pollutants. Ozone is a pollutant that has a very strong photochemical profile, and in addition can "travel" with the aid of atmospheric air. The criterion applied for assessment is the highest 8 hour mean of hourly values, calculated as a running average; a set of 24 values should be calculated for each day, each one representing the 8hour average of time intervals ending from 01:00 to 24:00 of the day of reference. The limit value is $120\mu g/m^3$ not to be exceeded more than 20 days per calendar year. It worthies noting that WHO has just introduced a new limit value, equal to 100 $\mu g/m^3$, a typical procedure in the domain of AQM, resulting from updated scientific evidence concerning consequences of polluted air to man and the ecosystem.

The above examples demonstrate the differences in the way that a pollutant affects ambient air quality should be taken into account in the design of any AQ information and communication methods and/or tools. On this basis, and following the mandates of the legal framework, the scientific prerequisites of the information content and current practice (Karatzas, et al., 2005), the information to be made available to the public should consist of (a) spatial and temporal air quality and emission data, (b) air quality forecasts (c) measures to decrease personal exposure, (d) guidelines for sensitive parts of the population and administrative details.

3. How people understand AQ

The way that people understand scientific information concerning the atmospheric environment has already been addressed in the case of warnings (WMO, 2002) or meteorological information for general use. When it comes to air pollution, people in many cases do not know how to find related information and if they do, they frequently complain that the information is unintelligible, while some have even seen it as an attempt of government to blind the public with science (Brimblecombe and Schuepbach, 2006). Bickerstaff and Walker, (2003), report that the first studies of human response to air pollution emerged already in the 1950s in the USA. People at that time expressed their environmental concerns while in parallel 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. Skamp et al (2004) describe student's ideas and attitudes about air pollution.. The majority of students identified the negative effects of air pollution for the environment and human health, and prioritized asthma as the disease to be directly associated with the problem.

The level of awareness and use of air quality information services is reported to be very low by Bickerstaff and Walker, 2004 (and references therein). 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. Moreover, Lindley and Crabbe (2004), suggest that IT tools should be used for the spatial representation of AQ related information, thus verifying the findings reported by Karatzas et. al (2004, 2005), concerning the APNEE-TU project.

4. Air quality information services (AQIS)

Information services for the quality of the atmospheric environment should, by definition, address information needs of citizens on the basis of effective communication methods. Those two are the key points for the design of any Environmental Quality Information Service (EQIS), and more specifically:

- Information needs. Those are defined by the way that the citizen envisages him/herself in relation to the physical environment, the interactions that he or she has or believes to have with such an environment and the impacts of the quality of the environment to his/her life, family, and personal ethical values that constitute quality of life. It is clear that these issues are very much influenced by the subjective view of each individual and by complicated (and in many cases uncertain) science that is involved in the cause-effect circle of environmental quality and well (sustainable) being. This means that a successful AQIS should be able to incorporate flexible and adaptable content, of varying scientific detail and of multiple graphical-verbal-multimedia representations. In addition, spatial and temporal characteristics of the information should be provided on the basis of service dimensions that will be able to address them (i.e. geo-references services for spatial data, time-dependent services for temporal variation of information, etc).
- Communication methods used. The effective communication of a message of informative nature that may escalate to a health hazard warning is the key for the success of every EQIS. As there are numerous publications on communication in general and on the communication of scientific content, it is better to focus on findings related to the atmospheric environment and specifically air quality. A first step is to identify the user (target group), by responding to questions like who is the user of the service, basic family and personal background in relation to environment, health and media technologies, scenarios of information usage, everyday life patterns, etc. Then, the information content should be addressed. According to AIRNET Thematic Network on Air Pollution and Health (http://airnet.iras.uu.nl/), "stakeholders prefer information to be presented in short overviews using non-specialist language". In addition, one of the findings of the airALERT that provides SMS-based air quality related health warnings in Sussex, U.K., is that people would like to receive health warning that advice them on the basis of their personal health condition in relation to atmospheric pollution, especially if they belong to the so called sensitive parts of the population (http://www.sussex-air.net/airalert_seminar.html).

Concerning AQIS, these issues have been addressed in a comprehensive and systematic way in the frame of the APNEE and APNEE-TU projects (www.apnee.org), as it is evident by the number of publications that the project produced, the impact it had to the research community[2] and by the number of off springs that it created. APNEE established a multi-channel information service platform for the dissemination and presentation of air quality information. The communication path made use of various telecommunication channels for pull and push service provision, indulging 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. The project results have been documented in various publications (Johansen et al., 2001; Bohler et al., 2002; Karatzas et al., 2004; Peinel and Rose, 2004; Karatzas et al, 2005).

Apart from APNEE, air quality information service content is briefly discussed in Beaumont et al., 1999. Moreover, and focusing on the web as the information channel, the Air Quality Bulletin[3], 2005, made a detailed study concerning UK and other web sites for air quality information. Findings support the use of simple, yet complete (from the scientific point of view) AQ content, enriched by graphics search facilities and search functions, giving links to other information sources, and providing information for children via games and other specially designed information modules. In addition, Pollach et. al., 2006, discuss that environmental web sites should make use of proper user navigation support functions, like

[2] Was presented by Commissioner Mrs Reding as one of the three success stories out of the total of ICT projects under the 5th FP.
[3] http://www.empublishing.org.uk/air/aqb5.pdf

search capabilities and site maps. 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 receive information related to monitoring and self-management of asthma, including avoidance measurements and prevention

5. Related R&D projects

AQIS have been in included in the agenda of R&D projects from the era of the 4th FP in EU. The first communication channels investigated were the ones supported by internet technologies in the frame of the Environmental Telematics initiative[4] and are reported by the Environment Telematics for Water and Air Pollution Management - Expert Group [5]. This led to the 5th FP, where a number of IST related projects addressed air quality management, information, and systems. The reference project was APNEE and its take-up measure APNEE-TU[6] 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. APNEE and APNEE TU (2000-2004) provided with a holistic approach to AQ information management and dissemination, and are a reference of success for EU projects[7], 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. Other projects like Appetise (2000-1)[8] focused on modelling tools for AQ forecasting, while Heaven (2000-2)[9] addressed traffic related air pollution. In parallel, projects like Clear[10] and Air4EU (2004-6)[11] successfully represented European air quality research. In addition, projects like CITEAIR (2004-7)[12] have studied a common AQ index and presentation of air pollution information on the internet, in a harmonised way. Some other projects were closer to the concept of environmental information services, like ENV-e-CITY (2002-3), which provided with a one stop shop of AQ related scientific services for administrators and practitioners. The same idea also inspired projects MARQUIS (2005-6)[13], 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, a new project has just started for the Greater Thessaloniki Area in Greece, for providing AQI via the internet and mobile phones, in easily understandable and human friendly manner[14], while the Government of Cyprus has recently announced the initiation of the operation of an air quality information service that includes a web portal and street panels[17].

It should be noted that in addition to the AQIS that have and are developed by research institutes and R&D consortia in the frame of various projects, there is a number of systems that are either originate from or resulted in a business activity. Those include:

[4] http://www.p2pays.org/ref/04/03870.pdf
[5] http://www.rec.org/REC/Programs/Telematics/ENWAP.html
[6] http://www.apnee.org
[7] http://europa.eu.int/information_society/research/success/index_en.htm
[8] http://www.uea.ac.uk/env/appetise/
[9] http://heaven.rec.org/
[10] http://dev.allez.no/clear/
[11] http://www.air4eu.nl/index.html
[12] http://citeair.rec.org/
[13] http://www.marquisproject.net/
[14] http://www.airthesss.gr

- Luftkvalitet[15]. The official Norwegian AQI site, developed and supported by the Norwegian Institute for Air research in the frame of their air quality management system AIRQUIS[16] and its information component AirOnline[17], that has also customers in Cyprus[18], Israel[19], Vietnam[20], and other countries (provides web based, mobile phone and street panel dissemination)
- AirWare[21], which is an AQ management system created by private company ESS, Austria (provides only web-based information dissemination)
- YourAir[22], which is an internet and SMS based air quality information service for London, U.K., provided by the consulting firm CERC.

6. Conclusions

There is a number of AQIS that have been developed as a response to the legal mandate to provide environmental information to toe citizens and the decision makers, and as a consequence of the scientific and technological developments in the fields of environmental sciences and ICT, respectively. Related literature has been accumulated, suggesting that this is a scientific field maturing fast, with considerable consequences in public administration, citizen participation in decision making and awareness and behaviour drives towards a more sustainable society. Personalisation of these services, in combination with the vast usage of internet and mobile phones in EU, is expected to lead to new types of (smarter) AQIS, that will allow for assessment of quality of life on a personal level based on mobility patterns and urban life characteristics. This is becoming more and more essential under the current conditions where the number of urban dwellers is increasing, in parallel with the development of a multimedia-digital world and digital services culture, which has opened a new market for personalised information services, especially via mobile devises and the internet.

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[15] http://www.luftkvalitet.info/
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