CUSTOMISED INFORMATION SERVICES FOR ENVIRONMENTAL AWARENESS IN URBAN AREAS

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SUMMARY

Air quality information furnishes a major business resource for regional governments to be offered as value-added services for citizens. From a citizen and city administration's point of view, the increase of the quality of air pollution information and the way of how this information is delivered to the citizen will produce a better quality of life and a much better communication and mutual understanding between citizens and city authorities. Project APNEE (Air Pollution Network for Early warning and online information Exchange in Europe) strives to foster the active dissemination of air quality information to European citizens according to "key action 1: system and services for the citizen" of the 5th Framework Programme. Once APNEE is in place, there will be a dedicated information service to inform citizens about air quality trends. Transparency of these trends acts as a mirror citizens have to face. This awareness might effect decisions on their actions in order to improve local and regional conditions. In this light, transparency translates into a consciousness of action, which will yield to a share of the responsibility among citizens and authorities and might eventually result in a change of citizen behaviour.

INTRODUCTION

> *According to a United Nations' prognosis, by the year 2010 there will be 26 cities in the world with more than 10 million inhabitants. A total of nearly 400 million people will be living in these cities – the population of the Europe Union distributed over 26 cities.* (9)

There is wide-spread evidence, that citizens call for timely and high-quality environmental information. This includes an easy-to-understand and easy-to-access presentation of this information. Several directives and regulations have been devised to improve levels of comfort and other conditions for quality of life. People will improve levels of comforts ultimately only due to their change of behaviour. But, any imposition on people has proven to fail rather constantly. Only an informed citizen will change his behaviour. The level of informedness corresponds proportionally to the quality of information services and the ease of operation from a users point of view. To meet such levels of quality, information services have to mature from passive pull services to active push services. These active delivery

services will enable citizens to interactively face impacts of their behaviour. Active delivery services resemble the concept of a mirror: it directly reflects the consequences of societal behaviour in terms or air quality.

Project APNEE[1] (Air Pollution Network for Early warning and online information Exchange in Europe) has been started in January 2000 to establish a uniform information portal on air quality in different European regions. APNEE will serve EU directives on information services for citizens about health affecting air pollution states. It strives to develop a technical umbrella for the distribution and customisation of existing air quality management systems. APNEE, in particular, employs several communication channels—be it short message services, mobile communication protocols, or street panels—to transmit information on air quality to selected citizens in urban regions in a customised fashion. Customisation refers to the tailoring of information content, i.e. the kind of warnings or recommendations for further actions, with respect to the user group registered, to the technical capabilities of the end-user devices targeted, and of course to the geographic location.

LEGISLATION BACKGROUND IN EUROPE

The national legislation in EU countries on air quality (AQ) information is founded on the general right of access to information, granted to the public. This right is based in the constitution in Austria, Germany, Greece, Denmark, the Netherlands, Norway, Portugal and Spain. Together with legislation on access to information in general, regulations related to access to environmental information have been approved in various EU countries. Therefore, all the above countries, except Portugal and Norway, and additionally Ireland, Switzerland and the UK have adopted law(s) that regulate the access to environmental information. These regulations are the result of the implementation of directive 90/313/EEC on the Freedom of Access to Information on the Environment of their National Legislation Body/System. Information provision to the public is also foreseen in directive 92/72/EEC (on air pollution by ozone), article 5. In addition, another recently adopted directive (99/30/EC, *URL*), related to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air, declares (already in article 1) the need for air quality information availability to the public, while devotes article 8 completely to public information. It is worth noting, that in the latter, and in paragraph 1, the use of computer network services is mentioned in order to provide the public with the appropriate AQ information. In addition, in the same article 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, the so called air quality framework directive 96/62/EC on ambient air quality assessment and management indicates in article 8 that "plans or programs formulated from appropriate authorities in order to combat air pollution and maintain air quality values within limits in certain heavily polluted urban agglomerations should be communicated to the public". Also in the same directive and in article 10, it is stated that when the alert thresholds are exceeded, member states shall undertake measures to ensure that the necessary steps are taken to inform the public. Last but not least, a directive regarding the freedom of access to information on the environment has already been but 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 (3).

[1] APNEE is supported by the European Commission DG B.4 under the 5th Framework Programme, IST-1999-11517, Key Action: Systems and Services for the Citizen.

Accordingly, information to be made available to the public may consist 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.

DISSEMINATION MEANS

The APNEE information system addresses the legislative and common demands as pointed out above by accommodating the following features (4):

I. Ability to treat spatially and temporally data,
II. Direct and easy access to AQ information,
III. Ease of update of AQ related information,
IV. Access to online data,
V. User-friendly presentation of AQ information in order to establish ease of use.

It is also equipped with data aggregation functions to further categorise data according to decision maker needs and the needs of the public.

Citizens may access the air quality information system in APNEE through different information channels:

- In the World-Wide-Web, a GIS-based interface founded in the concept of smart maps (5), (6), (7) guides the user to relevant air quality information at various levels of granularity.
- In the mobile world, SMS will be used for active dissemination of early warning enabled by subscriber services for concerned citizens, e.g., endangered people living in or approaching polluted regions.
- WAP-based services will provide more sophisticated information in terms of presentation, content, and navigation.
- In city environments, street panels will serve as public broadcasting means to inform citizens on forecasted trends.
- Voice servers will provide information by phone, while email can be used for active notifications.

Using real-time maps provides an innovative interaction metaphor for information navigation and exploration (8). Since pollution data is merely number based, online conversion and geo-referencing of this data yields to an intuitive dissemination of environmental ontime data. Employing also GSM, Voice servers, email and street panels beside the web establishes an overall accessible service based on the same data stock. Citizens can subscribe via web, fix or mobile phones to an automatic vocal or textual alert system. Going this way, they are informed in advance which part of the city to avoid during certain hours. Being mobile, a user's location is transparent. She can ask the system to give her detailed information for the area she is at this moment.

The project will take into account the different user profiles for the assessment of relevant information content and appropriate presentation.

INFORMATION SERVICES WITHOUT APNEE

A first study already conducted by the APNEE consortium consisted of an analysis of the actual information flow and services provided by the cities involved in the project towards the citizens (1). Observations include:

- Information granularity and flow does not go down to the street level, in order to inform citizens which parts of the city to avoid, even though geographical co-ordinates of monitoring stations are known (important for the participating cities which represent large agglomerations).
- Web services do not provide information in an interactive way and background information on interpretation of alert levels and protection methods for citizens are not detailed or not given.
- No possibility exists for citizens to easily access additional information after an alert (e.g., air pollution hotline). Static voice servers indicate the pollution levels for the current day without additional information on interpretation and protection mechanisms.
- No dedicated information services are available to allow most concerned citizen groups to get automatically informed (people with heart problems, asthmatic and elderly people, schools, etc.).
- Early warning and forecasting systems are not well known to the cities by now.

In addition, the APNEE consortium identified that no online services for professionals and decision makers exist to allow to share information in real-time and to accelerate decision making process in case of an air pollution alert.

CUSTOMISED INFORMATION SERVICES WITH APNEE

APNEE will enhance the information flow through an integrated air quality information system with a customisable portal for information encounter. Information access through APNEE will offer new quality levels of services to the citizen. Citizens are going to benefit from higher levels of interactivity, quality of information filtering, and active push services.

The citizens may certainly access the information system through different information channels based on wider spreading, modern information technologies:

- PCs, being either the personal home PC, or the PC on the office desktop. The only requirement is an Internet connection, since any Web browser can be used for this purpose.
- Electronic information panels aside the roads in the city and sub-urban regions.
- Mobile phones allow citizens to receive messages through SMS and to access information in an interactive way through voice and WML (HTML for GSM-WAP phones).
- Voice server as well as email notification.
- Other media, like radio, TV, and newspapers will receive and access audio, video and image files in common standard technology formats like MP3 (sound), MPEG (video) and JPEG (image).

APNEE will in particular employ several forecasting methods. These forecasting methods allow for a more detailed anticipation of upcoming trends. The new generation Air Quality Models (AQM) incorporate advanced forecasting capabilities which will be used to improve the capability to manage the air quality in urban and regional areas. One of the most important AQM is that related to the Ozone Source Apportionment Technology (OSAT) capabilities. OSAT allows a source apportionment. The OSAT and its derivatives, e.g., Anthropogenic Precursor Culpability Assessment (APCA), allows the new AQM's to track source region and/or source category contributions to predicted grid cell ozone concentration; thus, for any selected receptor point and time, the model gives a clear picture of the likely distribution of ozone and ozone precursors by source category and/or source region, as well as an indication

as to whether the ozone at the selected time and location would more likely respond to upwind NOx or VOC controls. The user will be able to know which grid cells will be most sensible to apply emission reduction strategies with maximum efficiency in order to fulfil the EU air quality directives. These emission reduction strategies will involve industrial reduction emissions or traffic emissions or even domestic emission reductions (heater, air conditioning, etc.) for the specific grid cells. These capability is foreseen to be extended to another pollutants (in addition to ozone). In case that traffic emissions are pointed out by the OSAT technique to be substantially reduced over specific grid cells, this traffic emission reductions will be implemented on the traffic models to redistribute the traffic flow accordingly to run the transport/chemistry model again (with the same meteorology) to determine the final effect on ozone. The advantage of OSAT is that the identification of grid cells with maximum sensitivity to emission reduction strategies will improve the efficiency of the different actions substantially. The APNEE system will eventually transfer this computed information to the citizen.

THE APNEE COMPONENTS

Figure 1 shows the APNEE core components. Existing local environmental information systems will by connected by a central meta model, which describes semantics, location, format etc. of the locally available data. This meta model, as well as extracted static data from these systems will be placed in a central database. The local systems will connect at a given time or when an air pollution alarm occurs to the central database, where the new information will be placed. Triggers in the central database will process these data and invoke the corresponding functions to generate alarms and update the respective interfaces. Cron jobs will periodically, e.g. each morning, submit forecast information on air pollution as bulletins by phone, email or SMS to subscribed citizens. With the help of a voice server, citizen can connect by phone and will be guided to the information the citizen is interested in.

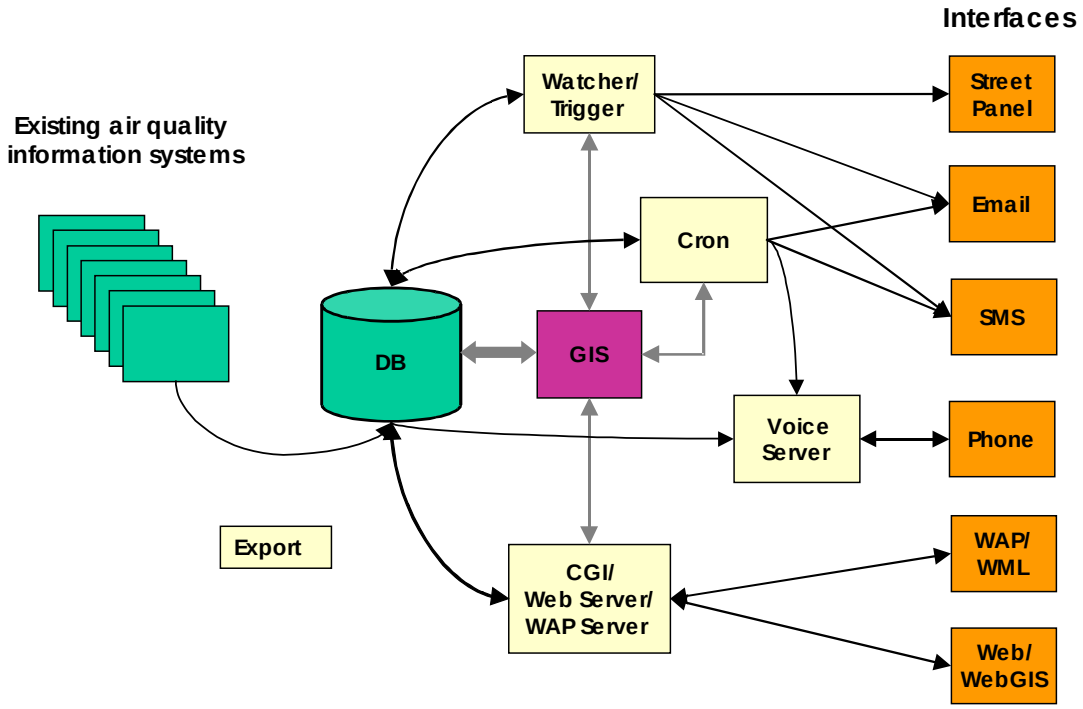

Figure 1: ***Sketch of the APNEE Components***

In addition, a combination of cron applications and voice server functionalities can call the citizen, if an alarm occurs.
The alarm functions will generate a small message concerning reason of pollution and region for mobile phones, phone call and street panels, and will produce more detailed information by email. Alarms uploaded to the central database will be checked for accuracy/correctness by local experts before transmission, to check if:

- measurements exceed a given threshold value,
- measurements and modelling results give different values outside a given ratio, or
- if any technical problem with the air quality surveillance system exists.

Main difference of the service types offered depends on the various information channels and the type of information dissemination, which can be categorised in display, push, pull, and interaction services (see also (2) for an more details about functions and assignments in APNEE):

Display:	simply display of information with frequent updates
Push Service:	"push" content to interested persons who subscribe to such a service on timely or event specific basis
Pull Service:	interested persons request information on demand, information will be returned on this request immediately by sending information
Interaction:	similar to pull service but direct user interaction for refinement of requests or parameterised requests possible

According to these types of services the interfaces of APNEE will offer to the citizen:

WAP/WML	pull services: a hierarchical structure of links to short ASCII information with small bitmaps (examples include: current pollutant values, regional thresholds, medical advises, thermal comfort, traffic overview, air pollution background information)
SMS	as push service warning messages, if a pollution alarm is given (what, who much, thresholds, advises), or at a give time short bulleting messages concerning forecast for a given period. SMS can also be used for pull services, i.e., the user sends via SMS a message to a SMS server, and will receive on special keywords (e.g., region identifier, pollutant identifier) respective information.
Phone	pull and push services: access to voice server, with access to additional information like medical advises, etc. (see WAP/WML), as well as direct warning calls if an air pollution alarm occurs.
Internet/Web	pull/display/interaction services: ▪ WebGIS: smart maps, presenting a navigational map of the local region with sensitive areas that animate geo-referenced air pollution information, functions for selecting layers of current or forecasted pollution or selection of additional informational layers, selection of regions and measurement stations, functions for starting predefined GIS queries, etc. ▪ links to additional and historical information, as well as medical advises, air pollution background information etc. ▪ bulletin boards, newsletter, discussion group facilities, related links, etc. ▪ user feedback services will allow to measure the success of the APNEE system as well as to react in time on user responses.

- subscribing service: users enter their co-ordinates/preferences including phone numbers, language preferences, pollutant names or indices, preferred regions, etc. This information will be used for all push services of APNEE.

Street Panels display service: current state of local pollution, medical and behaviour advises, general air pollution information, traffic conditions and advises.

In addition to these more citizen oriented services, special discussion groups for experts will be offered (restricted access). Results of discussions as well as newsletter information will also be translated in several user languages and be placed on a central server. This will enable the exchange of information among professionals, local and regional authorities in the urban area, between regions, but also across Europe, and European relevant institutions.

The GIS will be used for the generation of Web maps as well as for processing all interactions with maps. It will be further employed for interpolation calculations in order to generate map layers for level of different pollutants and level of air pollution index. In addition to such an intuitive presentation of information through means of geographical maps, GIS services will also be used for several computational purposes. First of all, GIS furnishes an essential information delivery service for weather simulation and forecasting. Air quality forecasting is for instance based on local housing conditions and traffic conditions. In the process of forecasting air quality estimates, the simulation model employs a GIS for local fossil uses. Secondly, GIS are used to derive regional classifications of forecasts and alerts. Then, a user can again browse with a map-based interaction metaphor on these sensitive regions. Finally, a GIS will also be employed to decide on appropriate information channels for the dissemination of air quality information based on regionally available communication infrastructures. The GIS will therefore serve as anchor point in the information infrastructure of APNEE.

CONCLUSION

Once in place, APNEE will provide a geographical information portal with proactive delivery services for dedicated user groups. APNEE addresses citizen services for information on air quality. APNEE's portal can be employed as platform for information dissemination. Doing so, APNEE allows regional authorities to "market" their service portfolio to citizens and regional entrepreneurs, while it also provides the basis for the application of an analytical framework that will be able to determine how much impact an air quality information policy in their region will have. From a citizen and city administration's point of view, the increase of the quality of air pollution information and the way of how this information is delivered to the citizen will produce a better quality of life and a much better communication and mutual understanding between citizens and city authorities.

From a technical point of view, information services might become more specific with regard to the geographical location of a citizen. In principle, it is possible to locate the mobile user by analysing cell information of the mobile communication network. This would allow a provider to send air pollution information to a mobile phone with respect to the region the user is currently located in. But, from a legislative point of view, this information is private, and can not be distributed for "commercial" purposes. Official procedures for determining how to distinguish between commercial services and somehow user-oriented public services are still not underway.

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