

Citizen-centred Dissemination of Air Quality Information on Multi-modal Information Channels: the APNEE Project

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Citizens call for timely and high-quality environmental information for reasons of comfort and health care. This interest recommends an easy-to-understand and easy-to-access presentation of such information. Rather than presenting raw data in an extensive fashion, one ought to engineer customisable information services, that can be tailored to individual user groups, be it for reasons of content or be it for reasons of citizen's reachability. In APNEE, we have been designing information services that draw upon various information channels, i.e. mobile-technologies, interactive portals for the Internet, as well as street panels for municipality usage scenarios. In a nutshell, the APNEE system promotes user-friendly information management and dissemination via multiple information channels, and can be applied in multiple information domains. Based on such high quality dissemination potentials, environmental information can join the new type of electronic information services now becoming more and more popular, once perceived and provided as indicators for emerging interests of citizens towards levels of comfort and quality of life indexes. Yet, commercial content providers have to be attracted to offer this kind of services, be it as portal or messaging services. In this paper we report on the design of information services that are offered by non-governmental and commercial organisations. Field trials unveiled the preparedness and willingness of the citizen for services on a charge basis if the value-added can be "grasped".

Introduction

The citizen is interested in environmental information once presented in a form customised to the individual preferences and responding to individual information access needs (Beaumont *et al.*, 1999). The need of citizen-centred information dissemination in the environmental sector is a concept that continuously gains support, as it is supported by the corpus of the European Union environmental legislation and is part of the sustainability agenda.

In this paper, we are focusing on the domain of air quality information. Air quality represents an attractive domain for new information services, as it is among the environmental problems ranked as top priority issues from citizens. As urban air quality is of dynamic nature, changing continuously with time a combination of forecasting methods and access to on-line, near real time measurements is essential, as field trials, conducted in the frame of APNEE, have proven.

Although several European directives offer guidelines to provide the public with appropriate information on air quality, reports on active information services are sparse. Most publishing approaches are limited to mere tables, and there is no approach addressing early warning and dynamic information providence. Though air quality information is available in the Internet or even on WAP servers, the use of the Internet and new communication technologies is rather at a low scale.

EU directives advise that the public should be kept continuously informed, with the aid of appropriately prepared information that would not require scientific expertise to be interpreted, but would rather make use of a simple, well structured, indicator-based air quality related “vocabulary”. This vocabulary is usually based on the use of a combination of a colour scale and associated verbal characterisations corresponding to air quality levels, although there is still a lack of a pan-European perception and common scientific understanding, that is reflected in the absence of a common indicator scheme. The latter can easily be explained if one takes into account the “peculiarities” of each individual country, that pose a considerable scientific and political challenge if one wishes to address air quality problems throughout Europe on a completely homogenised basis. Thus, though appropriate presentations and interpretations of air quality (and environmental information in general) towards the citizen are requested, exact means on how to do so remain vague. Since authorities have to meet the directives, most requirements elicitation studies are authority-based, i.e. authorities pose the requirements on how to inform the citizen. Yet, one has to move from an authority-based approach towards a citizen-centred dissemination, if one wants to reach the citizen. Thus, environmental information services should be drawn by addressing both authorities about their capabilities and willingness, and citizen requirements about their personal preferences with regard to information content, presentation and ways of access. This need has recently been pointed out in a survey conducted in order to reveal aspects, requirements and perspectives on improvement of environmental information concerning an environmental information system for London (Haklay, 2000).

The citizen-centred design can be seen as the approach to the development of interactive systems that mainly aim to make all available environmental information usable and accessible, regardless of the modality of information channel. These requirements recommend a dissemination platform that provides an array of information services to reach the citizen. It further recommends sophisticated customisation services. Customisation ranges from the type of content, other the form of presentation, up-to the point of access provided depending on the reachability of the citizen.

In APNEE (Air Pollution Network for Early warning and information Exchange in Europe) (APNEE, 1999), we have been designing information services that draw upon various information channels, i.e. mobile technologies, interactive portals for the Internet, as well as street panels for municipality usage scenarios. The advantage of APNEE lies in its customisation facilities. Information on air quality are tailored in terms of content, presentation and dissemination, i.e. the kind of warnings or recommendations for further actions, with respect to the user group, to the technical capabilities of the end-user devices, and of course to the geographic location.

This paper reports on the citizen-centred dissemination platform of APNEE, its customisation facilities and lessons learned. The paper is organised as follows. Section 2 motivates the customisation of information services towards the citizen, while section 3 introduces the service portfolio of APNEE in a bird’s eye perspective and refers to the overall architecture and the dissemination approach. Experiences gained in field trials are reported in section 4, while section 5 reflects business perspectives.

Citizen-centred Environmental Information Systems (EIS)

The need of citizen-centred information dissemination in the environmental sector is a concept that continuously gains support not only because of the increased interest in the environment but also due to the recognition of the environmental information as a valuable asset to-

wards a sustainable urban planning. This need has already been pointed out in a survey conducted in order to reveal aspects, requirements and perspectives on the improvement of environmental information of an EIS for London: London Environment Online (Haklay, 2000). The citizen-centred design can be seen as the approach to the development of interactive systems that mainly aims to make all available environmental information usable and accessible, regardless of the modality of information channel. The primary design principles of this kind of design can be characterised by

- dedicated awareness of the potential users requirements,
- significant efforts to design as simple as possible,
- (re-) use of existing standards and technologies,
- user-oriented control and freedom of navigation, and
- prevention of errors and provision of error recovery.

In the London Environment Online study it was concluded that the public should not be treated as a one-piece monolithic body, but that the multiple identities and profiles of each individual user should be considered carefully. The definition of user requirements and needs is unique for each EIS user. Most users view environmental information as a set of interconnected matters of their daily lives, express interests in various directions and consider environment as a cumulative picture. In addition, a review of the existing public EIS demonstrated the lack of plurality in the design of such systems (Beaumont *et al.*, 1999). The amount of available environmental information increases rapidly during the last years, while it is stored on different platforms and in different formats, and organised according to various constructing schemes and models. Another survey suggested that providing air quality (AQ) information and data on their own is insufficient, while most responders revealed a high degree of concern on possible health impacts of air pollution and wished to learn more about (individual) ways of contributing in order to reduce poor AQ circumstances (Beaumont *et al.*, 1999). From the above surveys, the demand of localised and regional environmental information was recognised. Most users stressed the need for a simplified language, so as to eliminate the possibilities of misunderstandings and inconsistent interpretation. In similar studies, the obvious preference to processed data and interpreted information has been stressed (EPA, 1998). Meta information, the information that can be seen as a hint to another information or data source, in the form of maps or Air Quality Indexes provide attractive ways of information packaging, visualisation and presentation and is thus suggested that they should be implemented in the public EIS design.

The APNEE Approach and Architecture

Information services have to mature from a passive delivery task towards a pro-active, customisable service, that orchestrates data for a specific purpose and employs appropriate information modality whilst reaching citizens, that might have even subscribed to specific profiles.

The APNEE solution is based on one common central system allowing new users sites as well as new interface providers to easily connect to the system.

The beauty of this approach is the ease of connecting new air pollution management organisations (APMO) to the APNEE system by building only an export filter to the APNEE central database (Figure 1). That is, APNEE provides in principle the dissemination core, i.e. broker platform, employing several communication channels to be used by content providers, in our case information on air quality and levels of comfort.

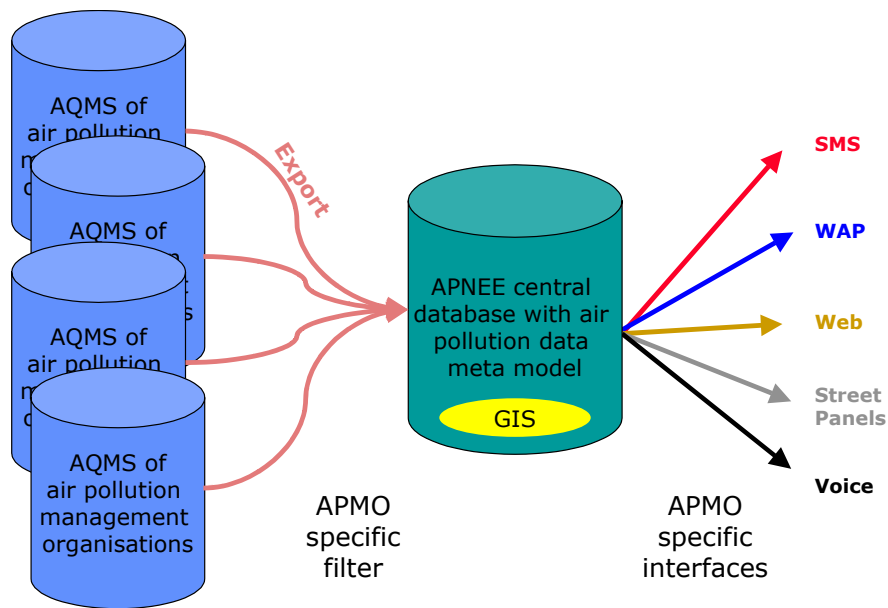


Figure 1. The APNEE dissemination platform.

While the mobile interfaces have to be implemented with respect to the telecommunication providers involved in APNEE, the web solution as well as the subscription service are based on one common platform, open source and freeware for all user sites. Separation of layout and content allows easy adaptation to new user sites reflecting their individual corporate identity as well as of course language and country specific issues.

Mobile access and street panels for new user sites are also easily connectable to the database, but individual technical architectures and modules of telecommunication providers require a little more effort for implementation.

Based on this open approach new components can be connected. “New” components include and will be tested in the follow-up project APNEE-TU:

- Additional user sites with data sources provided by regional data providers (selected regions in Germany, Oslo in Norway, Canary Islands and Andalusia in Spain, Thessaloniki in Greece),
- Alternative types of data to cover new information domains, such as pollens,
- Emerging devices and communication channels, such as PDA (Personal Digital Assistant) connected via GPRS as well as smart phones with GPRS and UMTS.

In APNEE, citizens can access the air quality information system through different information channels (Figure 2): In the *World-Wide-Web*, a GIS-based interface founded in the concept of smart maps (European Commission, 2002) guides the user to relevant air quality information at various levels of granularity. In the *mobile world*, SMS is 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 provide more sophisticated information in terms of presentation, content, and navigation. In *city environments*, street panels serve as public broadcasting means to inform citizens on forecasted trends. Voice servers provide information by phone, as well as email is used for active notifications.

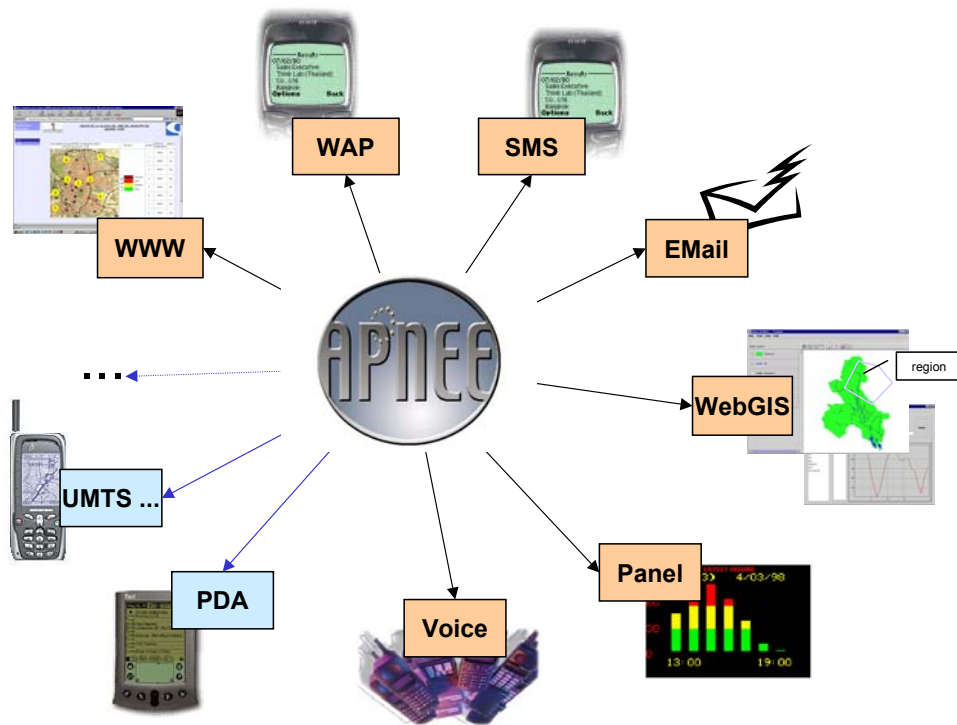


Figure 2. The APNEE service portfolio.

Reflection on Field Trials

Field trials have been conducted in several European regions. The content and design of information services has proven crucial for the success. Rather than eliciting requirements from the viewpoint of city and regional authorities, the citizen should be at the heart of any requirements elicitation, although research in requirements engineering suggests to put less emphasis on the actual “end-user” thus suggesting that a balanced, expert view approach should be used. On the other side, experience from extreme programming suggests to engineer services in tight co-operation with end-users. Both approaches have been trialed in APNEE, the citizen-centred one has developed extremely well. One important point is that this approach also requests significant resources to interview citizens and monitor the impact of information services.

In the region of Marseilles intensive user interviews have been conducted to elicit citizen requirements. Citizens show a crisp interest in environmental information when presented in a way that receives a high level of acceptance and understanding. Moreover, beyond the mere dissemination of information, one also ought to convey recommendations for action to be taken by citizens, an approach that proved to be effective as some members of the test panel claimed that they changed their behaviour because of the information provided. Yet, the design of the information services has proven resource intensive, that is the content and type of presentation was adapted in two cycles leading to the version currently available. Moreover, the field trial unveiled the need for a harmonised classification schema concerning Air Quality Indicators: The ATMO index has proven successful, because it gives a clear rating of the state of air quality ranging from 1 to 10; information is easy to understand.

A technology-driven approach has been followed in the Madrid field trial. SMS, WAP and Internet services were at the heart of the field trial. While the SMS experiment was comparable to the Marseilles one, the WAP service revealed significant differences. Similar to the Marseilles trial, usability studies preceded the system design; the animation of environmental

information on low resolution devices was the challenge in this case. Imaging the display capabilities of a mobile phone and the resolution requested for the display of a roadmap. This endeavour yielded in an iconic presentation of major traffic lines replenished with emoticons presenting the state of air quality. Once designed and available in online operation, field trials were conducted in a commercial portal. High rates were achieved with relation to WAP services. The distribution of accesses shows peaks during typical break times, and before and after rush hours. Hence, people are interested to receive information on air quality and potential limitations of restricted areas. Moreover, a commercial exploitation as premium WAP services is on its way, based on a business model for bundling service in a premium service. The comparison of the Madrid with the Marseilles field trials unveiled some cultural differences. While the French trial capitalises on voice servers and the citizens rather neglected WAP services, the Spanish trial showed a preference of WAP services with exceptionally high hit rates.

Yet, future extensions have to put more emphasis on indexing means. The citizen requests a crisp classification of the state of air quality in the sense of traffic lights. An index, such as the French ATMO one, has proven successful. Authorities and related parties have to agree on this kind of index although there is some reluctance from a scientific and political point of view. More intuitive means for presenting a set of arrays are also requested. If several indicators describe the environmental quality, one has to decide on the priority of indicators and their potential impact: inform the citizen in an appropriate form, but do not scare him/her. By the same token, one should think in terms of level of comfort and quality of life, rather than presenting environmental indicators as “red signal” of a traffic light. Instead of dunning, a combination of bio weather (already successful in Germany), “felled” temperature and a combination of air quality indicators might offer a compelling information service for life-style.

The ultimate goal of APNEE is a change of citizen behaviour based on high-level quality of information. Proof of this kind of impact is still open. Some indications have been gained in terms of interviews where users in the Marseilles region have reported a change of behaviour based of the information conveyed. Yet, representative research requires more and longer termed empirical studies.

Reflection on Business Perspectives

APNEE has developed an information service platform for the dissemination of air quality information. The portfolio of services has to serve a wide spectrum of communication because there is no common denominator. Cultural differences, regional requirements, and varying types of pollution recommend individual configurations of communication modes and content orchestration.

Although the overall concept has proven attractive to the community of user sites, individual business plans emerged. Each user site has developed its business concept to further operate the services already in place.

APNEE has proven its concepts at a European scale. Yet, commercial viability has to be seen at an individual level. Partners teamed up at country level to offer dedicated services consisting of a subset of the entire portfolio.

Yet, a European business perspective for a sustainable business path is still lacking. Partner objectives impact individual business plans. If someone is in the domain of non-governmental

organisations and obliged to non-profit services, then the prime interest is to improve citizen awareness. Environmental information is not considered as commercial content to rise access rates on a charge basis, while by the same time, increased access rates are definitely their “business” interest, but in light of citizen awareness. Technology and service providers on the other hand are seeking business opportunities. Level of comfort and quality of life is definitely a service opportunity. Here it is, where dedicated partnerships evolved carefully tailored to regional requirements and organisational business objectives.

The business perspective has witnessed more promising results. The concept of APNEE and the experience gained so far in the field trials have attracted more commercial partners, as proven by the fact of starting a large-scale take-up measure. Commercial content providers perceive APNEE as a new type of content to attract customers; APNEE-TU will start as test bed to evaluate the business asset of environmental content.

In particular, the question arises of how to finance this kind of services. Several business models have been elaborated in APNEE. Services on a charged basis seem unattractive, although SMS services for traffic information and metro/subway information have proven successful in metropolitan areas. Service bundles for “greening purposes” appear as natural solution. But there is evidence that once turned into levels of comfort, acceptance raises. Rather than receiving raw data, the citizen is interested in high quality information services: “give me a forecast replenished with recommendations for individual activities”.

Field trials in Norway revealed further business opportunities. Once individual behaviour is affected, citizens are voicing pricing confessions: “once this information service is in place, I would afford 4 Euro for subscribing to this service”. Regardless of the pricing scale, this experience backs the experience of the Marseilles trial; people are prepared to subscribe to this kind of services on a charge basis, once they can “grasp” the value-added for their live.

Conclusions

The APNEE system promotes user-friendly information management and dissemination via multiple information channels. Based on such high quality dissemination services, environmental information can turn into an attractive product once perceived and provided as indicators for emerging interests of citizens towards levels of comfort.

In a *technology stance*, APNEE provides an information service platform to disseminate spatially and temporarily varying information. It has been successfully tested for air quality information in urban environments. Individual citizen needs are met by APNEE’s multi-modal information services. Yet, the question arises how to implement this kind of services from a technology point of view. Technology standards are still missing to offer SMS or WAP services at a European scale. Moreover, they seem to be tailored to individual service providers, i.e. each bulk broadcasting of SMS messages requires individual interfaces for each provider. WAP has a higher degree of interface compatibility, yet each interface has to be tested on a huge set of phones. WAP also comes with a higher cultural affinity. Besides difference in access performance, language influences the design of services.

In a *business stance*, APNEE implements an electronic supply chain of environmental content from certified sources, over commercial content service providers, to customers. This cross-business chain has proven crucial for the success of APNEE. Commercial content providers seek new content opportunities and are eager to provide quality assured information. Envi-

ronmental institutions provide quality assured content, but not in an attractive form. Here it is where two business opportunities meet in the clouds of public-private partnerships.

In an *information society stance*, APNEE is a first step towards e-environment that is intended to offer environmental information as a professional business service towards the citizen while it provides the first pan-European reference for harmonizing environmental information provided towards the citizens, thus producing a considerable momentum for a commonly accepted way of defining and using air quality indicators. . Future extensions will be explored to established information of the environment as attractive service that reaches the citizen and is based on an economical sustainable basis.

APNEE has started as an RTD measure with support from the European Commission and is now starting further field trials in the course of APNEE-TU as take-up measure. The APNEE information service platform will be extended in APNEE-TU (APNEE Take-Up) to new mobile devices (PDAs and smart phones based on GPRS and UMTS) as well as new regions (in Germany, Norway and Greece) and additional information services (levels of comfort).

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