LOT 1: Public Access to Environmental Information

Case Study: AirINFORM Partnership Project

Air Quality Forecasting Model and Public Information System Developed in Yangzhou

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1. Project outline and objectives

The project objective is to improve Air Quality (AQ) information systems and public awareness tools in pilot cities of China to enhance public access to environmental information. The project originates from the understanding that communication of AQ policy and providing correct, attractive, appropriate and convincing AQ information plays an eminent role in maintaining public confidence in the authorities.

The project was located in three pilot cities**:** Yangzhou, Taiyuan, Urumqi, which are located in regions stipulated in the 12th Five-Year Plan (2011-2015) on Air Pollution Control in Key Regions and thus obliged to improve AQ during the 5 year period and where Yangzhou became the key city for testing and developing the forecasting model and public information approach.

Project Duration: 01 Nov 2012 - 31 Oct 2014

Project partners: The project was carried out by the Vlaamse Instelling voor Technologisch Onderzoek N.V. (VITO) (Flemish Institute for Technological Research) (Belgium) together with Beijing Antipollution Environmental Engineering Co.; Chinese Academy for Environmental Planning; DCMR Environmental Protection Agency Rijnmond; Beijing LIBOVITO Environmental Technology Co.; Urumqi City Environmental Monitoring Station; Shanxi Academy for Environmental Planning and Yangzhou Environmental Monitoring Central Station.

2. Project Approach

Air quality information system review and stakeholder consultation

In order to evaluate the existing AQ information systems and air quality information dissemination in China, AirINFORM carried out a review of AQ systems operating in China including the recently revised Ambient Air Quality Index (AQI) Regulation[1]. According to this regulation, Environmental Monitoring Centers (EMCs) must publish the daily average and Near Real Time (NRT) / hourly AQI values of their ambient AQ monitoring locations. It was noted that the revised Chinese AQI differs from other AQI-s that are available in China though various apps and websites. This has two consequences: the public might be confused by the different results and secondly, the EMCs have to make great efforts in their communication as they are in fact competing with third parties for the attention of the public. Furthermore, from a communicative aspect the suggested messages associated with the AQI should be reviewed as they are currently related to short term risk communication. The Chinese air quality is not yet good enough for this to be a good communication strategy. Lastly it is very important to look at the AQI grid for the hourly particulate matter (PM) concentrations. The use of the same grid for the hourly and daily PM currently occasionally leads to very high AQI values which are not correct and unnecessarily disturbing. This should be remedied. The AQI should also be supplied to the public in an appealing manner combined with other relevant information so that it can be

[1] The Technical Regulation on Ambient Air Quality Index (on trial) which was revised in 2012 outlines a newly developed AQI system (HJ633-2012 – on trial) which includes the pollutants PM2.5 and Ozone (O3) which were not formerly included. This legislation replaces the previous Air Pollution Index (API) regulation.

easily understood. It should contribute to the EMC website/app becoming the prime source of environmental information.

To ensure the perceptions of needs for improvement of the AQ systems, the project conducted a 'stakeholder consultation survey' in the early stages of the project. The survey provided insight into the needs of the Environmental Protection Bureaus (EPBs) in pilot cities regarding AQ information and communication and allowed project implementing partners to customize the system design. This need was driven by the "12th Five-Year Plan on Air Pollution Control in Key Regions", which obliges the most polluted regions to establish air pollution "Monitoring, Early Warning and Emergency Response Systems" and publish timely information on the air quality. The core indicators suggested the need for timely, reliable NRT and forecasted AQ data to assess the air quality and warn the public of any heavy pollution days. In contrast to the air quality systems based on complex chemical transport models (CTMs), the system should operate using limited available input data, have less reliance on expert AQ modellers, be simply designed and user friendly.

Air Quality Information System Design

This was in contrary to the original plan to improve the existing demonstrative CTM based forecasting service that had already been established in Yangzhou in a previous trial project. Instead, based upon the user requirements, the project set out to develop a system with a proven EU developed statistical based forecast model at the core which uses readily available AQ measurement data rather than emissions data. This also provided the project with a valuable opportunity to compare the CTM and statistical based AQ forecasting services; to highlight any deficiencies and to gain further insight into problem areas.

The system design was based on both the immediate AirINFORM user requirements and any future requirements for air quality management. Thus it comprises of components not only for air quality forecasting but also tools for air quality decision support management e.g. assessing the source of pollution or predicting the AQ for a future year based on emission reduction plans. The system was generically designed, allowing easy extension with additional functionalities.

Within the project, the statistical based forecasting and NRT mapping component called OPAQ (an Operational Prediction Air Quality framework) was developed. OPAQ is an advanced statistical AQ prediction system based upon an ensemble of neural network statistical models which predict pollutant concentrations at given monitoring stations. These models (RIO (NRT), OVL/SMOGSTOP) have been used for many years by the Belgian authorities to complement their AQ information dissemination. The current ensemble of statistical models are complemented with a number of different machine learning techniques and adequate ensemble post-processing in order to yield better results than any of the individual models. Furthermore, a few iterations of the prototype were foreseen to capture as much as possible, the needs of the end users.

User friendly web services were also designed for the different pilot cities so that the EPB staff can easily view the AQ maps (NRT and forecast), assess the raw data and evaluate the performance of the system using the post processing tools. Each city decides what information would be shown to the public, but as a minimum the near-real-time air quality and forecasted AQI and pollutant concentrations are normally shown.

Air quality Information System Implementation and Capacity Building

Selecting Yangzhou city in Jiangsu Province, as the focal pilot city for this activity, the project implemented the OPAQ information system enhancing public accessibility and improving the capabilities of local EPBs. Key challenges that had to be overcome in transferring these models to the Chinese market were the adaptation to a data-sparse environment and simplification of the deployment process. Given the statistical nature of the models, training data treatment and quality control is essential. As a result user friendly optimisation and quality control tools were developed based upon Hampel filters and Gaussian anomaly detection methods.

These tools also proved to be very useful in showing the end users how 'poor' their measurement data was. This is invaluable considering the general status of the AQ monitoring networks in China, which in some regions still need considerable improvement. They also help to ensure that the Chinese implementing partner, LIBOVITO can configure the operational models for other Chinese cities in the future.

Alongside the implementation, several technical exchange workshops and visits were organized throughout the project to discuss the use of AQ models to assist the EPB's meet the requirements of the recent Air Pollution Control Action Plan of the State Council as well as the work plan of MEP. The pilot cities are under huge pressure to reduce their emissions significantly and demonstrate the impact using modelling tools. Hence learning from the EU's experiences was important. During these technical exchanges, the AQI evaluation and the system implementation process the following important related recommendations were taken into consideration:

- In early 2013 AQ concentrations were higher than the AQI scale which goes up to an AQI of 300. It was recommended that another pollution band be added to the limit of 500
- The PM10 moving 24-hours value averaging period for the AQI is not dynamic/fast enough to be used as a reliable NRT indicator thus leading to a false impression of the AQ therefore it would be better to introduce a 1 hour indicator system;
- There is need for temporal and spatial AQ information to supplement the AQI in order to allow interested public understand the values origin;
- When applying models for policy support, the type of model should be selected based on the fit-for-purpose criteria. Simple statistical models for both spatial mapping and forecasting may be a better reliable and cost efficient option in an operational setting in contrast to complex deterministic air quality models
- Much more support to local EPB's in understanding and implementation of complex air quality information (emergency response) systems is required
- To assist in implantation of action plans aimed at reducing air pollution, capacity building and the acquisition of scenario modelling tools, reliable emission data (of all sectors, not just the industry and power) and data on the cost of emission reduction strategies are needed

In order to test and improve the modeling tools, reliability testing was performed in Yangzhou between the AQ forecasts provided by the OPAQ statistical model and the existing demonstrative CTM based forecast. As predicted early on, in this situation the performance of the statistical model was superior due to the fact that it is less sensitive to input data. At the end of the project, thanks to OPAQ, Yangzhou are reporting daily forecasted AQI values to the public up to 3 days ahead and also providing a comprehensive overview of the AQ across the province, reporting the key pollutants SO2, NO2, PM10, ozone and PM2.5. This according to Ms. Chen, the deputy director of the monitoring center, allows them to reliably forecast heavily polluted days and episodes. OPAQ enables medium to small cities to establish an affordable, easy to operate AQ forecasting system that is less sensitive to data availability. These factors are especially important for small and medium sized Chinese cities, and/or cities with limited financial capacities.

Raising Public Awareness and Media Activities

Awareness campaigns in Yangzhou strongly indicated that whilst informed public can access websites and apps (high profile target group, fast to communicate), the great majority of the public is unaware of the AQ problem and requires very simple non-technical AQ communication. In response, simple informative material was developed to be demonstrated in schools, local TV channels etc.

Hence to complement the web-based AQ information system the project developed communication and awareness tools to improve public understanding and encourage participation in AQ issues. This comprised

of public questionnaires (reaching over 1000 citizens), simple animation films and displays to ensure general public understanding of air pollution and the potential health impacts.

Moreover in order to advocate the new tools for better AQ information and to provide the public with a better understanding of AQ indices, the project undertook various media activities in all three pilot cities, concentrating most of the efforts in Yangzhou including: production of TV programs which communicate information on the AirINFORM project, implementation of the AQ modeling tools and encourage public participation; special media coverage (Yangzhou Daily, Yangzhou Evening News); producing a project brochure/fact sheet; display panels at prominent open public places, presenting information on AirINFORM; organizing stakeholder communities visits to the AQ monitoring networks and AirINFORM system placed in the city and organizing local workshops and regional seminars.

3. The European ingredients

The AQI evaluation and the air quality communication advice were provided by the EU partner DCMR, who is the licensing and inspection authority in the Port of Rotterdam Area. DCMR brought in over 40 years of experience in improving public interaction and dissemination of air quality information. In the EU CITEAIR projects, DCMR together with Airparif, developed a new common air quality index that is currently well accepted in Europe for the purpose of real-time comparison of urban air quality (www.airqualitynow.eu).

The complete AQ system design is based on the ATMOSYS AQ platform (demo: www.atmosys.eu) developed by VITO within an EU funded LIFE+ project. The NRT and forecast mapping functionality as well as the model validation module were adapted and tailored to meet the Chinese city's requirements. The core models at the back-end of the system were developed in Belgium and are currently being used by the Belgian authorities for dissemination of air quality information to the public. As well as providing the tools, VITO shared valuable information on their experiences of applying these tools and other AQ management tools in the EU, to assist the local partners in meeting the obligations of the new National Airborne Pollution Prevention and Control Action Plan (2013-2017).

4. Transferability to other parts of China and Sustainability

Throughout 2014, demonstrations of OPAQ were given to more than 15 cities in the provinces of Hebei, Heilongjiang, Shanxi, Shaanxi, Jiangsu, Shandong and Inner Mongolia. Reaching well outside the project's local partner provinces of Shanxi, Jiangsu and Xinjiang. By early 2015, the OPAQ system is also now operational with positive results in Jinan, Chengdu, Tianjin and more recently Chongqing and Nantong EPB's. Aside from the system at Jinan and Yangzhou, the remainder have been established by the Chinese partner LIBOVITO with minimal support from the EU partner, ensuring transferability of the service to the China. As better input data becomes available from the cities, the systems will be continually improved.

The set of three small animations that were produced to increase the awareness of the public on air quality issues are the most sustainable output of the public awareness activities. They have been made freely available to all stakeholders and will be used by the local partners in continuing public awareness campaigns. Furthermore, the pilot city partners plan to repeat some of the awareness activities (visits to monitoring station, play the movies) on an annual basis. Finally, the recommendations gathered during the project concerning air quality information collection, management and communication were made to Ministry of Environment.