Installation of Ambient Air Quality Monitoring System

To Support Evidence-based Air Quality Management Under the Urban-LEDS II Project

Narayanganj City, Bangladesh

ICLEI Local Governments for Sustainability

UN HABITAT FOR A BETTER URBAN FUTURE

Case Study - Installation of ambient air quality monitoring

System to Support Evidence-based Air Quality Management Under the Urban-LEDS II Project

- Narayanganj city, Bangladesh

Introduction

Project Objectives

Under the Urban-LEDS II project, one of the pilot interventions identified for the city of Narayanganj, Bangladesh was the setting up of Ambient Air Quality Monitoring Systems (AAQMS) at different locations within the city. The objectives of the pilot project in Narayanganj, Bangladesh were as follows:

- Determine the status and trends of ambient air quality
- Monitor the levels of air quality necessary as per the ambient air quality standards to protect public health, vegetation, and property
- Assist in setting goals for air pollution control that will also contribute to mitigation and GHG emission reduction
- Use project results to inform the land use/spatial planning for siting of industries and residential communities as well as for green cover planning to achieve the overall goal of improved air quality in the city

Rationale of Intervention

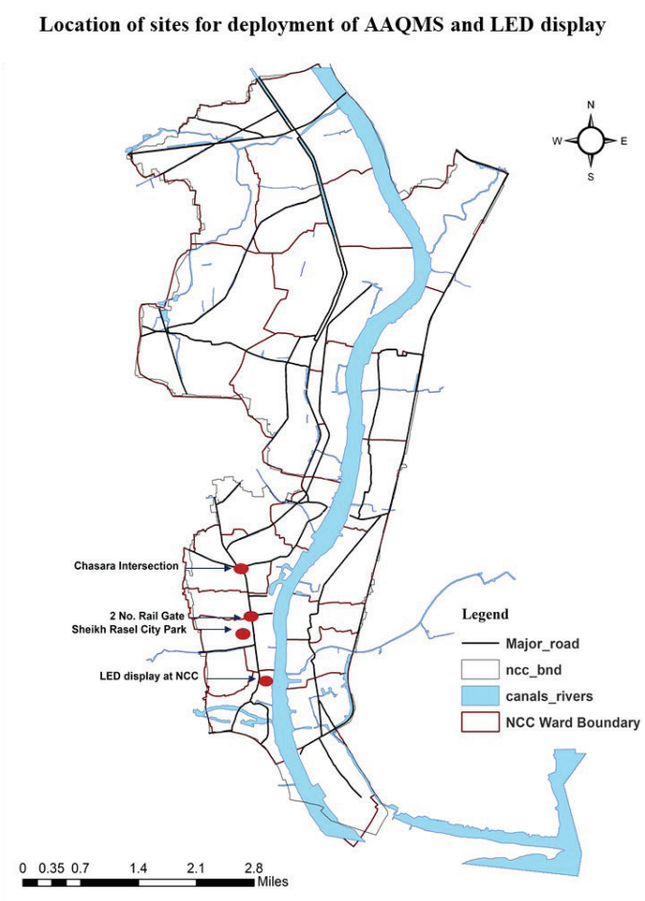


Figure 1: Map of Narayanganj showing location of sites for deployment of AAQMS and LED display

Summary

Total geographical area: 72.43 km^2
Population size: 709,366 (Census 2011)
Population density: 9794 hab/km^2

Snapshot of the Case Study

Narayanganj is an industrial city with textile industries, rerolling mills, cement factories, and brick kilns. Air pollution from industries as well as increased transportation activities adversely impacts health of the city residents. Installation of stationary sensor-based AAQMS and portable Ambient Air Quality Monitoring devices was thus deemed necessary, and therefore Narayanganj City Corporation was identified as a pilot location by the Urban LEDS Phase II project to implement evidence-based air quality management practices. Through a technical feasibility study, the locations were identified based on land use, pollution sources, wind direction and potential of higher air pollution impact. AAQMS were installed in three identified locations at Narayanganj city.

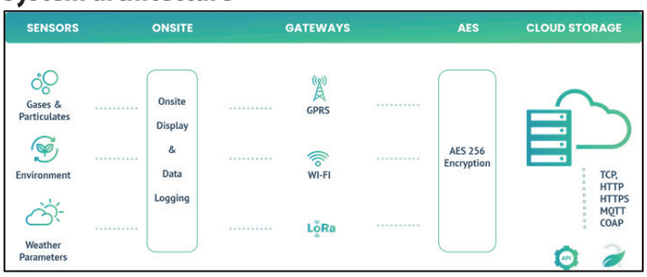
Narayanganj is a city located in the Narayanganj District in central Bangladesh near the national capital of Dhaka. It is the sixth largest city in the country with a population of 709,366 in 2011. It is a business and industry center, especially for jute mills, processing plants, and textiles. It is nicknamed the Dundee of Bangladesh due to the presence of its many jute mills. Narayanganj was identified as the 17th city with the worst air quality out of 1600 world's cities. Very high level of air pollutants was found, including carbon monoxide, sulphur dioxide, nitrogen oxide, ozone, methane[1]. In 2018-2019, electricity consumption in residential, commercial, and institutional buildings contributed to 30% of total GHG emissions in Narayanganj. To implement climate resilient actions in Narayanganj, ambient air quality monitoring system was installed as a pilot project under the Urban-LEDS II project.

During 2012-2018, the Ministry of Environment, Forest and Climate Change of the Government of Bangladesh implemented the Clean Air and Sustainable Environment (CASE) Project to identify and manage the gross air polluting sectors in eight cities in Bangladesh including Narayanganj. The study identified Narayanganj as the most polluted city in Bangladesh with very high levels of particulate pollution with an annual daily PM_{10} concentration of 210 µg/m^3 which is several times above the WHO annual air quality guideline value (5 µg/m^3 annual mean)[2]. Narayanganj City Corporation intended to supplement the national database that is captured through a AAQMS operated by the Department of Environment. The project results will therefore enable national policy makers and planners to implement evidence-based air quality management practices and create public awareness on the issue.

Technical Aspects of the AAQMS

The pilot installations included appropriate hardware, software, and real-time data logging with digital connectivity through GPRS/ GSM modems. A portable handheld air quality monitoring device along with calibration kit was also provided to Narayanganj City Corporation.

System architecture



LED Display: Helps to clearly display air quality as monitored by the sensors for public awareness

Hardware: AQI parameters included PM_{10}, $PM_{2.5}$, NO_2, O_3, CO, SO_2; Weather parameters include temperature and humidity; connectivity was through GPRS, and installation includes 220v AC Power Supply.

Software Solutions: It features Geotagging of devices; Shows AQI of the selected location, temperature, and humidity; Provides suggestions based upon recent air quality of the location; Shows AQI trend of the location over last 24 hours with minimum and maximum values; 1-hour average values of the selected parameter over last 24 hours; and Realtime data visualization and remote calibration.

Frequency of data capture/logging on the portal: 1 minute

Sensors: There are three categories of sensors used for measuring air pollutants: a) Laser Dust Sensors in which laser or light scattering principle is used to obtain the number of suspended particulate matter in a unit volume of air; it can measure Particulate Matter (($PM_{2.5}$, PM_{10}). b) Gas Sensors that operate using Fuel Cell Technology, are more accurate, and are used to measure the air quality parameters like CO, NO_2, O_3 and SO_2. c) Weather related sensors that measure temperature, relative humidity, and noise.

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Organisations, Stakeholders, Location, period of implementation

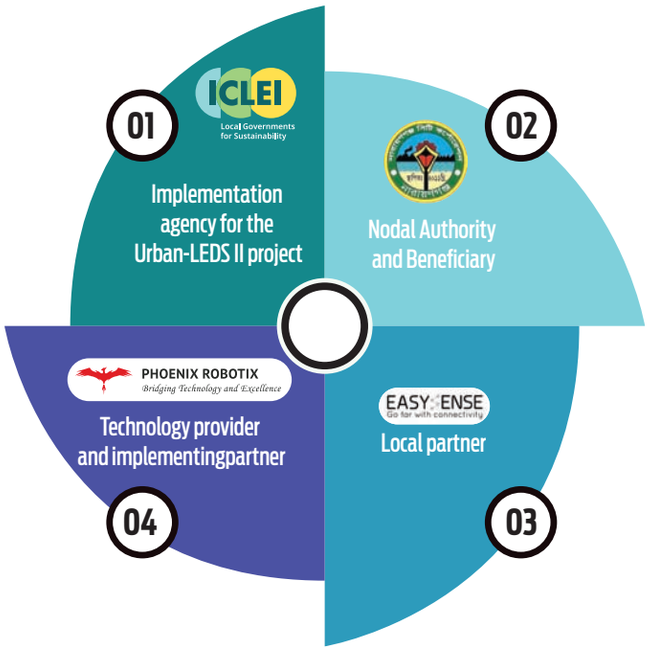
The pilot project has been installed at three locations: Chasara intersection, Bangabandhu intersection and Sheikh Rasel City Park. Sensor-based stationary AAQMS with communication modules were installed with one 4 foot x 5 foot LED display near the building premise of Narayanganj City Corporation. The technology provider/implementing partner will be responsible for Operation & Maintenance (O&M) for a period of three years to ensure the effective functioning of the devices/systems.

The partners for implementing the pilot project were Narayanganj City Corporation, ICLEI South Asia (through its offices in New Delhi, India and Dhaka, Bangladesh), M/S Phoenix Robotix Private Limited (based in Rourkela, Odisha, India) and EasySense (Local partner contractor of PRPL, based in Dhaka, Bangladesh).

Project Activities

Inputs

Information gathered from a technical feasibility study, conducted in September 2020 helped to identify appropriate locations within Narayanganj for the installation of AAQMS.



Outputs

- Commissioning and installation of air quality monitoring sensors at three locations to capture and monitor air quality. The LED display helps to clearly display the monitored air quality for public awareness
- Setting up of the complete AAQMS system with sensors, communication devices/loggers, and LED display.
- Provision of portable ambient air quality monitoring device to officials of Narayanganj City Corporation that can be applied for wide area air quality surveys and checking pollution "hotspots".

Planning process

As a preparatory baseline assessment for the pilot project, the Narayanganj City Corporation and ICLEI South Asia team conducted site surveys and a technical feasibility study to identify suitable locations for the pilot installations in the city. In September 2020, five potential locations were initially identified for technical feasibility study including Chasara, Bongobondhu Chattar 2-No Rail Gate, Mondal Para, Bandar Launch Terminal and Chittagong Road. After assessment of landuse and pollution sources, suitable spots and establishments were identified for mounting AAQMS. Several factors (security, structure height, pollution sources, wind direction, wind flow, landuse etc.) were considered during the selection process. As per the technology requirements, the optimum height for installing AAQMS was 10-15 feet above ground to capture air quality appropriately. The study also looked at local wind-flow patterns across different seasons. This feasibility study helped to ensure that the sensors were able to capture accurate air pollution data that can be effectively used by Narayanganj City Corporation in urban planning decisions. ICLEI South Asia consulted with the project partners on integrating air quality data in national database after installation of AAQMS. Based on the technical feasibility assessment, in June 2021, three sites were finalized for the pilot intervention - Sheikh Rasel City Park, Chasara Intersection, and Bongobondhu Intersection at 2 No. Railgate.

Methodology

The different steps of the pilot project are described below.

- **Pre-assessment:** Information gathered from a technical feasibility study and site surveys helped to identify appropriate locations within Narayanganj for the installation of AAQMS. The feasibility study also helped to identify the air quality parameters to be monitored and finalize the devices/ technology to be installed.
- **Procurement and installation:** Three sensor based stationary AAQMS devices, equipped with CO, NO_2, SO_2, O_3, particulate matter (PM_{10} and $PM_{2.5}$), relative humidity, temperature, and noise sensors and communication modules were installed in Narayanganj city. In addition, one portable handheld air quality monitoring device with calibration kit was provided.
- Real time data was made available for efficient access through remote client interface and made available on the website of Narayanganj City Corporation via a dashboard. To this end, the appropriate hardware, software, and data logging with digital connectivity through GPRS/ GSM modems, were appropriately licensed.
- LED display was installed near the main administrative building of Narayanganj City Corporation to display real time data and generate awareness within the community.
- Air quality data for all key parameters was stored from the devices, enabling monthly reports to be generated and shared with Narayanganj City Corporation.
- **Operation & Maintenance (O&M):** A three-year O&M contract was signed for all the monitoring stations to ensure smooth functioning beyond the project period.
- **Training:** Comprehensive training program was conducted for officials of Narayanganj City Corporation to understand the functioning and O&M requirements of the stationary AAQMS and portable ambient air quality devices. Periodic calibration would be carried out for the sensors to ensure proper operation.
- **Post-project sustainability:** The project design supports a robust post-project sustainability plan. It ensures that the outputs of database, periodic reports, will continue to be generated (even after the closure of the Urban-LEDS II project) through the three-year O&M contract that has been put in place.
- Training of officials of Narayanganj City Corporation ensure long-term sustainability of project activities and outputs. Through the knowledge gained and skills developed from the training programs, the officials of Narayanganj City Corporation are expected to apply their expertise to design, plan and scale up such efforts for Narayanganj in the future.

Understanding the opportunities

The potential opportunities of the pilot project were to assess the extent of air pollution in the city; spread awareness and share air pollution data in a

timely manner; support enforcement of air quality standards; evaluate the effectiveness of emissions control strategies; help inform urban planning and decision-making; provide information on air quality trends; and support associated long-term research.

Project Benefits

Addressing Climate change and promoting urban sustainability

Air pollution is a major public health hazard. In 2019, Bangladesh ranked as the most polluted country in the world, in terms of critically high levels of air pollution with $PM_{2.5}$ of 83.30 µg/meter cube[3]. The city of Narayanganj emitted 1.07 million tonnes of CO_2e of GHG emissions in 2018-2019. Installation of air quality monitoring system is critical to understand and minimize human exposure to harmful air pollutants by data-driven decision-making by authorities. Air quality monitoring project at Narayanganj can establish linkages between air pollution and climate change because local level monitoring can provide more robust data as compared to results from regional and national level monitoring. The pilot project in Narayanganj is a great starting point and will help the city to move in a positive direction towards improvement of air quality, and also combat climate change.

Specific benefits of the project in Narayanganj city

The health effects of cleaner air, for example, the decline in PM_{10} in the case of Narayanganj, can be directly tied to fewer diseases (asthma, heart diseases), and deaths[4]. The project will support city to implement evidence-based actions aiding the improvement of air quality and reducing health impacts on its residents.

Linkages to Policy

The 2030 Agenda for Sustainable Development recognizes that air pollution abatement is important to the attainment of the Sustainable Development Goals (SDGs). Through the project actions, the city of Narayanganj will contribute to two SDGs: SDG 3.9 (substantial reduction of health impacts from hazardous substances) and SDG 11.6 (reduction of adverse impacts of cities on people).

Challenges

Challenges faced

The variable primary emissions, industrial emissions, meteorological transport dynamics, and other complex secondary processes makes air quality management very challenging. Also, a very common (anticipated) challenge was the effectiveness and accuracy of sensors. For the pilot project, identification of the appropriate sensors was seen as a challenge from the city government's perspective during the pre-assessment phase, given the limited know-how and in the absence of similar technology being installed locally.

Addressing the challenges

The project team planned appropriate training programs (highlighting the technical and management issues) for concerned stakeholders. The project has provided support by organizing training for staff of Narayanganj City Corporation for stationary AAQMS and portable ambient air quality devices, and to carry out periodic calibration of the sensors. As a solution to identifying appropriate technology (sensors), the project team brought in relevant expertise/experience to help with the selection of appropriate technology.

Lessons Learnt

The pilot project clearly demonstrated that cities can take local-level efforts to supplement "clean air" goals in a cost-effective manner. While national governments and public institutions have goals and plans to expand air quality monitoring networks/systems, such systems are costly and may not have resources and capacities to execute such a large scale, especially for developing countries like Bangladesh. The sensor based AAQMS thus offers a decentralized and cost-effective solution. Cities can replicate this project to get better localized data and supplement national efforts (Dept of Environment/CASE project).

There is a dire need for creating an ecosystem for enabling adoption of sensor based AAQMS by more cities in Bangladesh, with active participation from private entities and city residents. Technology innovators and businesses can help addresses air pollution challenges by investing in the growing market for sensor technologies. These sensor-based technologies are very relevant for cities to understand the real-time air quality, as well as to assess and take data-driven decisions pertaining to the air pollution sources and health risks from pollution. Such decisions may include, but not limited to, investments in clean transportation, creating pollution-free zones, land use changes as well as design, alter and enforce air pollution/emissions control rules. This project has provided a unique opportunity and shown a clear pathway for technology innovators, academia, private sector and civil society to link public health and technology to better air quality management.

Narayanganj City Corporation has and will be taking ownership of the climate resilient solutions and resources created under the Urban-LEDS II project. The residents of the city under the leadership of the City Corporation will be the prime beneficiaries of this system, and can therefore share lessons, and provide scientific and other key insights on how to establish, monitor, maintain and use data from the air quality monitoring network with others. In that way, other cities and key public institutions throughout the country will be able to consider replication and scaling-up efforts of the project in the future.

Urban-LEDS II project: A Quick Snapshot

The Accelerating climate action through the promotion of Urban Low Emission Development Strategies (Urban-LEDS II) project is a global initiative being implemented in more than 60 cities in eight countries. Urban-LEDS II supports participating local governments on low emission development to reduce greenhouse gas emissions and to simultaneously enhance resilience to adapt to climate change.

The project is funded by the European Commission and implemented jointly by UN-Habitat and ICLEI – Local Governments for Sustainability. It follows on from the first phase (Urban-LEDS I) that took place from 2012 to 2015. ICLEI South Asia (SA) is leading implementation of Urban-LEDS II in India and Bangladesh with support from UN-Habitat. The cities were being supported through pilots on climate action and planning (based on the vision, priorities, ideas, and opportunities identified by the cities). Urban-LEDS II and ICLEI SA are supporting these initiatives by way of technical and financial assistance.

Project Duration: 2017-2021

Model cities in India: Nagpur, Thane (deep-dive implementation), Rajkot (knowledge-sharing)

Satellite cities in India: Coimbatore, Gwalior, Panaji, Pimpri-Chinchwad, Shimla (learning cities)

Model cities in Bangladesh: Narayanganj, Rajshahi (deep-dive implementation)

Satellite cities in Bangladesh: Singra, Sirajganj, Faridpur, Mongla (learning cities)

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