TERMS OF REFERENCE
for
Developing Advanced Air Quality Forecasting System – Integrating & Analyzing the Air Quality Forecasting Data

I. Background

As part of the "Sustainable Development Strategy (SDS): Egypt Vision 2030",[1] the country committed to halving its fine particulate matter (PM_{10}) air pollution by 2030. Significant improvements have been made towards that goal in recent years. In fact, Cairo's PM_{10} concentration fell by about 25 percent over the past decade. Despite these improvements, the city's pollution levels are still several times higher than the WHO recommended concentrations and higher than national guidelines resulting in a significant public health toll and degradation of quality of life of the population, especially among the poor. Recently, the Greater Cairo (GC) Cost of Environmental Degradation (COED) attributed the highest environmental cost – by far – to air pollution, with a mean estimate equivalent to 1.35 percent of national GDP in 2017. Conversely, the GC COED attributed to waste (net of air pollution damages, via the burning of waste) is half that of air pollution's COED equivalent to 0.68 percent of national GDP in 2017, which includes the opportunity losses from composting, recycling, methane capture, etc. Moreover, recent studies on COVID-19 show that there is an increased likelihood of contracting the disease in places with high levels of ambient pollutants.[2]

Climate change models project Egypt's mean annual temperature to increase between 2 ºC and 3 ºC by 2050 and an increase in the duration of long-lasting heatwaves. Hot sandstorms known as khamasin blow millions of tons of grit from the Sahara to the North African coast and increases in local temperatures of up to 20 ºC are projected to increase in frequency and intensity. By 2050 the intensity and seasonality of heavy rains, as well as the probability of droughts will increase. Long-lasting heatwaves likely will increase in duration of between 9 to 77 days by 2085. The GC area is vulnerable to each of these climate impacts, as well as to river and urban flooding, water scarcity and wildfires. The impacts can be severe, particularly for public health and agriculture. Climate change will put additional pressures on citizens' health, in the form of increases in the prevalence and severity of cardiopulmonary conditions through heat and sandstorms, potential increases in vector-borne diseases, through decreased nutrition

[1] http://www.cabinet.gov.eg/English/GovernmentStrategy/Pages/Egypt%E2%80%99sVision2030.aspx and https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Egypt%20Vision%202030%20%28English%29.pdf.

[2] Larsen, Bjorn. 2019. Egypt: Cost of Environmental Degradation: Air and Water Pollution. The World Bank. Washington, D.C.; and Back of the envelop calculations for cost of solid waste environmental degradation performed by the Team.

and food security and reduced water quality. Further, it has been demonstrated that extreme heat events are linked to worsening air pollution.[3]

In response to this situation, the Government of Egypt (GOI) is implementing the Greater Cairo Air Pollution Management and Climate Change Project (hereafter "The Project") financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo, i.e., Cairo, Giza and Qalubiah Governorates[4], and is implemented by the Ministry of Environment through its Egyptian Environmental Affairs Agency (EEAA) and its Waste Management Regulatory Authority (WMRA) and in collaboration with other partners. A Project Coordination Unit oversees overall project implementation and ensures that fiduciary requirements are met.

The Project aims specifically to reduce emissions that contribute to air pollution concentrations, thus leading to air quality improvements, and to simultaneously mitigate climate change. Air pollutants include PM_{10} and $PM_{2.5}$, while climate pollutants include both longer lived greenhouse gases (GHGs) such as CO_2, as well as Short-lived Climate Pollutants (SLCPs) that include black carbon, methane and several short-lived HFCs.

The Project is composed of the following 5 components:
Component 1: Enhancing the Air Quality Management (AQM) & Response System.
Component 2: Support the operationalization of SWM Master Plans in GC.
Component 3 Vehicle Emission Reduction.
Component 4 Communication & Stakeholders Engagement.
Component 5: Project Management and Monitoring & Evaluation.

The requested services covered by these terms of reference are **to support implementation of Component # 1 of the Project, on Enhancing the Air Quality Management (AQM) and Response System, implemented by EEAA.** This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

Component # 1 comprises two subcomponents:
- Subcomponent 1.1: Reduction of air pollution and GHGs.
- Subcomponent 1.2: Strengthening resilience to air pollution.

The Consultant's assignment is related to Subcomponent 1.2: Strengthening resilience to air pollution, and the following Sub-tasks:
- Development of an advanced Air Quality Forecasting system; and
- Development of AQ Public Awareness Website.

More information on the Project's Components, and detailed information on Component#1 is mentioned in **Annex # 1**.

[3] Markandya and Chiabai, Valuing Climate Change Impacts on Human Health: Empirical Evidence from the Literature, Int. J. Environ. Res. Public Health, 6, 759–86, 2009.

[4] More details on the Project Components are provided in Annex 1.

The project has contracted The Cyprus Institute under Component # 1 Subcomponent # 1.1 to assess EEAA existing air quality monitoring networks including the air quality early warning system, and to develop Tender Documents, Terms of Reference (ToR), and detailed technical specifications for establishing an advanced early warning system according to EEAA requirements. The Cyprus Institute started conducting the assignment since early September 2023.

II. Objective of the Assignment

The main objective of the assignment is to develop an advanced Air Quality Forecasting system by a qualified consulting firm, referred to hereafter as "the Consultant". The Consultant will also be asked to develop a public information portal that provides the general public with information on air quality conditions.

III. Scope of Work and Detailed Tasks:

The Consultant is requested to conduct the following tasks:

1. **Study recommendations for EEAA new advanced early warning system:**
   Review relevant reports, documents, recommendations, and detailed technical specifications which have been developed for establishing EEAA advanced early warning system by other consults for EEAA, and integrate that information into the design, development and deployment of an advanced air quality forecasting system.

2. **Development of advanced Air Quality Forecasting system:**
   Develop an enhanced AQ forecasting program through a two-phase approach consisting of a scoping phase and subsequent implementation phase, both of which build on existing forecasting capacity for both poor air quality days and climatically extreme events. Air quality forecasting tools shall be improved through development of a chemical transport model-based approach, and its integration with local air quality monitoring data.

   A. Scoping/Review Phase:
   The scoping / review phase includes implementing the following activities:
   - A review of EEAA's current air quality forecasting procedure, modelling tools and IT systems in use, and all associated data that feeds into this process.
   - Interviews to understand the aspirations of EEAA with respect to improving the current air quality forecasting system and providing an early warning system.
   - Preparation of a review report and forecasting system delivery plan/road map, including IT, staffing and training costs/requirements in close consultation with EEAA.

   B. Implementation Phase:
   Developing an enhanced forecasting, and early warning system which includes both anthropogenic emissions and natural sources e.g., dust events, includes implementing the following key activities:
   - **Air quality modelling:**

- Regional meteorology model: which is often used to provide meteorological inputs to air quality models of all scales. WRF is the most deployed meteorological model in the world. These are typically run in an operational setting with sophisticated supporting IT infrastructure.
- Regional air quality model: including both anthropogenic and natural sources and used for regional forecasting of air quality and to provide chemical boundary conditions for more localized models. The most common models in this category are CMAQ, WRF-Chem and CAMx. These are typically run in an operational setting with sophisticated supporting IT infrastructure like the meteorological models. Sometimes a trajectory model (like HYSPLIT) is also deployed to compute air parcel trajectories that might explain a past pollution event or forecast future events.
- Development of an operational AQ forecasting system: This should run in a live forecasting environment to provide hourly results out to 48 hours and support an early warning system. Key features may include incorporating regional dust model, HYSPLIT trajectory model, integrating with EEAA's emissions inventory and international inventories, and checking statistical accuracy.
- Post processing framework: this can include websites, automatic reports and a range of other digital outputs. These tend to be very specific to the case.

➢ Assist with any potential procurement related activities that result from AQM forecast system design recommendations (e.g. new servers, computer hardware, or IT infrastructure that may be needed to support operational use of the system).

3. Create a public information portal:

The public information portal shall provide access to information on the following:
(a) general background on air pollution / public action;
(b) current conditions / AQ index and local observations and data; and
(c) forecasts with self-protective actions for public/ sensitive populations.

The final configuration of air quality data online delivery will be tailored to EEAA's requirements and aspirations, but are likely to include:

- Dashboards;
- Maps showing monitoring stations;
- Area concentrations displayed through contour maps; and
- Integration with early warning system to provide notice or alerts for potential high pollution events or dust storms

Approach & Methodology:

- A website interface, specified to ensure compatibility with existing systems, will be built to allow interactive access to the new database features and tools.
- The interface should allow analysis of all current and historical measurements and present the results as report quality graphics, CSV files for spreadsheets and R data objects using Openair.
- Air quality monitoring data should be provided in a suitable format for display, dissemination and publication.

- It may also be beneficial to require provision of a portal for web access to the powerful suite of Openair data analysis tools. This will add additional value to air quality data including maximizing the value of the meteorological data allowing fast and effective analysis of likely sources of pollutants under different conditions.
- Different levels of access will be provided on the platform for general public and decision makers.
- A wide range of tools are available for implementation within a final reporting solution providing everything from wind and pollution analysis, to analysis of seasonal or annual trends with meteorological factors decoupled.

4. **Capacity Building, and knowledge transfer:**

The consultant will ensure the transfer of knowledge to EEAA staff, and build their capacity to operate, maintain, validate/QA, and update the AQ forecasting system via training sessions, workshops, meetings, seminars …etc.

IV. Administrative Arrangements

The Consultant will work under the supervision of and report to the Head of the Environmental Quality Department, in his capacity as the Head of the Technical Implementation Unit of Component # 1 of the Project, and/or his designee, and with the Lead Advisor of the Component. Contract management and other administrative responsibilities are overseen by the Project Coordinator of the Greater Cairo Air Pollution Management and Climate Change Project, or his designee.

The consultant will closely work with EEAA staff members of the TIU, and will collaborate as needed with other partners that are also supporting EEAA staff with AQM planning.

V. Duration of the Assignment and Time Schedule for Deliverables

The consultant will work to complete deliverables between within **15 months** from the start of contract.

Serial No.	Deliverable	Time from Contract Effectiveness
1	– Inception Report: approach to the assignment, objectives, detailed methodologies in respect of each activity, activities schedule, mobilization plan, progress to date, expected difficulties and assistance required, meetings held and persons met. – Roadmap &Training Plan.	3 weeks
2	Air Quality models: – Regional meteorology model – Regional air quality model – Operational forecasting system – Post processing framework	10 months

	– Report on the AQ models.	
3	Support procurement and deployment of the equipment for the AQ forecasting System	10-13 months
4	Air Quality public information portal	15 months
5	Training sessions & workshops	During contract period
6	Operational Manual	15 months
7	Quarterly progress Reports	End of every quarter
8	End of Mission Report	1 week after end of mission in Egypt

The Consultant shall report to and work under the supervision of the Head of the Environment Quality Sector of EEAA.

All results, data (raw and final), reports should be delivered to EEAA in an electronic (editable), and 3 hard Copies.

All reports will include a summary and be written in English with an Arabic translation. Reports would be prepared initially in draft and finalized within an agreed upon period following receipt of comments from EEAA.

V.II Minimum qualifications

Consulting Firm minimum qualifications:

- Consulting firms are expected to have successfully completed and demonstrated experience with at least 3 similar projects in developing advanced air quality forecasting systems, requiring complex data analysis, and environmental assessments in low- and middle-income countries; with hand-on capacity building and institutional strengthening components.
- The firm is expected to have a minimum of 10 years experience providing consulting services in environmental management and planning.

The Consultant's staff will be available for meetings and appointments per the schedule of the EEAA. The Consultant is requested to present a Quarter Progress Report with the results to EEAA / MoE every 3 months during the contract period.

Key experts qualifications

The consultant team composition must include at least the following key experts

No.	Position	Qualification	Experience
1	Team Leader – Air Quality Management Specialist	Ph.D. in Environmental Engineering, Chemical Engineering, earth science or similar field.	A minimum of 15 years of experience working in the field of air quality management is required. This individual brings extensive international experience and provide depth of knowledge on air quality forecasting, and management. Experience with similar projects funded by World Bank or other development partners are preferred.
2	Air Quality Forecast Modeling Expert	Master's degree or above in atmospheric science, environmental science, or related discipline.	A minimum of 10 years of experience of atmospheric chemistry, air quality modeling, and the behavior of pollutants. Experience in conducting air quality assessments, interpreting monitoring data, and analyzing emission sources and their impacts is necessary. Track record of at least 10 years of experience in AQ forecast modeling software and tools.
3	Geographic Information System (GIS) & Data Analysts / Statisticians Specialist	Bachelor's or master's degree in engineering, geography, geospatial science, statistics, mathematics, or a related field.	A minimum of 5 years of experience. Expertise in GIS tools and spatial analysis techniques. Experience in integrating data with spatial information, mapping, and conducting spatial analysis to identify hotspots and pattern, including advanced regression modelling. Proficiency in handling large datasets, data processing, statistical analysis, and data interpretation.

			Experiences with similar projects funded by World Bank or other development partners are required. Good spoken and written English language skills is required.
4	Media and Communication Expert	Master's Degree or above in Media, Communication Engineering, or relevant field.	A minimum of 10 years of experience in environmental and public awareness field. Experiences with similar projects funded by World Bank or other development partners are required. Good spoken and written English language skills is required.
5	Portal/Website Developer	Bachelor's Degree or above in IT Engineering, Communication Engineering, or relevant field.	A minimum of 10 years of experience of developing websites. Experiences with similar projects funded by World Bank or other development partners are required. Good spoken and written English language skills is required.

A total of **28 person-months** inputs are expected.
The presence of the Consultant's team members in Egypt is expected to be around a total of **10 person-months**.

The Consultant team should include expert who is fluent in both speaking and writing the Arabic language to assist the consulting firm in public awareness activities and website development.

Scheduling
The Consultant will prepare the proposed schedule of activities and staff mobilization plan at the inception stage; and these may be reviewed and revised every six months in response to EEAA's needs and in agreement with EEAA.

Client's Input and Counterpart Personnel

Services and facilities may be made available to the Consultant by the Client:

- EEAA as possible shall assist with arranging meetings with local Government and other authorities as necessary during the course of the consultant's work.
- EEAA shall make available to the Consultant the available air quality data, emissions inventory, meteorological data and air quality index data as relevant to the conduct of the Project.
- EEAA shall make best efforts for collaborative working arrangements with EEAA, PCU, and counterpart staff.

The consultant will report directly to:
Head of Environment Quality Sector,
Egyptian Environmental Affairs Agency (EEAA),
Ministry of Environment.

The Consultant will also work closely with the World Bank members of the Project team.

Annex 1
Greater Cairo Air Pollution Management and Climate Change Project

Brief on the Project :

The Government of Egypt (GoE) is currently implementing **Greater Cairo Air Pollution Management and Climate Change Project** (the Project) financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in GC, i.e., Cairo, Giza and Qalyubia Governorates and is being implemented with Ministry of Environment (MoE) in close collaboration with Ministry of Local Development (MoLD), Qalyubia Governorate, Cairo Transport Authority (CTA) and other stakeholder agencies. The Project focuses on two main sources of air pollution: solid waste management and vehicle emissions in GC region and includes the following five main components:

Component 1: Enhancing the Air Quality Management (AQM) and Response System:

This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

Component 2: Support the Operationalization of Solid Waste Management (SWM) Master Plans in GC:

This component aims to support operationalization of Governorate SWM master plans, which lay down the full range of necessary actions and investments needed for each governorate to improve SWM services in accordance with the specificity of each Governorate. In view of the complexity and magnitude of SWM system in GC, the Project follows a phased and gradual approach to achieve tangible results on the ground. This approach involves providing technical support at the central level to the Waste Management Regulatory Authority (WMRA) and the MoLD and specific investments, technical, financial and project development support to SWM actions at the local level to the Qalyubia Governorate.

Component 3: Vehicle Emission Reduction:

This component_aims to support activities aimed at reducing vehicle emissions from public transport sector. This shall be achieved through procurement of about 100 electric buses and the infrastructure required to operate and maintain these buses. The component will also support the CTA in acquiring the needed knowledge and experience in operating and scaling up electric bus fleet in Cairo. The Project will also upgrade facilities at CTA, including retrofitting existing bus depots with electric charging stations, power supply and related safety equipment; training CTA staff such as bus drivers and mechanics on operating and maintaining the new e-equipment.

Component 4: Communication and Stakeholders Engagement:

This component_aims at ensuring that all stakeholders, in an inclusive manner, are actively involved in the design, implementation and monitoring of all Project activities and the Project is implemented following a full consultative participatory approach that is meant to build a constructive relationship between the stakeholders and the GoE. This component is

complementary to the comprehensive Stakeholders Engagement Plan (SEP) developed as part of the environmental and social risk management.

Component 5: Project Management and Monitoring and Evaluation (M&E):

This component will support the establishment of Project Coordination Unit (PCU) at MoE and four Technical Implementation Units (TIU) for each of the first four components.

Component 6: Enhanced E-Waste and HCW management for Reduction of uPOPs:

It is an additional finance (AF) to the parent project, this new activity focuses on reduction of unintended persistent organic pollutants (uPOPs) aligns with the "GEF Project Design and Review Considerations in Response to the COVID-19 Crisis and the Mitigation of Future Pandemics".

Brief on Component 1: Enhancing the Air Quality Management & Response System.

This component comprises two subcomponents:

- **Subcomponent 1.1:** Reduction of air pollution and GHGs. This subcomponent will support the carrying out of a program of TA activities on reduction of air pollution and GHGs, namely: (a) development of an Integrated Climate and Air Quality Management Plan (IC-AQMP) including a time-bound action plan for its implementation; (b) strengthening Air Quality Management (AQM) regulatory and policy tools through (i) developing a mobile source emissions inventory including road and nonroad sources, and integrating it with existing inventories and (ii) continuous monitoring of short lived climate pollutants, greenhouse gases, and carbon dioxide monitoring; (c) development and rolling out of a specialized AQM and green jobs skills training program in universities and ministries including curricula such as chemical engineering, atmospheric science, environmental economics and environmental health, renewable energy interventions, energy efficiency and environmental economics, and resource efficiency/circular economy interventions; and (d) strengthening policy dialogue by carrying out assessments of the environmental health and the economic benefits of priority climate and air quality interventions, including cost-benefit and cost-effectiveness of emission abatement investments and capacity-building initiatives such as the trainings program.

- **Subcomponent 1.2:** Strengthening resilience to air pollution. This subcomponent will strengthen resilience to air pollution through:(a) improving air quality forecasting tools through development of a chemical transport model-based approach and its integration with local air quality monitoring data and dissemination of the forecasting information; (b) establishing institutional response mechanisms for high pollution days such as definition of criteria and protocols for identification of air quality action days and development of emergency plans and applicable decision protocols for said air quality action days; and (c) strengthening the technical capacity of the National Committee for Crisis Management and Risk Reduction for implementation and enforcement of the protocols.

  These two subcomponents are to be achieved through ten "Sub-tasks" (bundled into fewer subcontracts that achieve the same intent):

1. Establishment of a SLCP/GHG Monitoring Network for GCA–to support in providing recommendations on the deployment, operation and maintenance of proposed network, (structured in a scoping and subsequent implementation phase).This network should integrate seamlessly with and support existing AQ monitoring networks (ambient & industrial) in GCA (including routine AQ monitoring sites in GCA as well as the recently designed source apportionment network and the telemetry monitoring system for point source of industrial facilities), thus an initial step shall involve conducting a network assessment to review EEAA's comprehensive AQ monitoring objectives and, QC/QA and requirement for enhancement road map. Implementation activities will include design and deployment of network components (including source apportionment and PM2.5/BC/CO2 monitoring components), but also analysis, data management, and quality assurance of GCA monitoring program.

2. Establishment of an integrated Emission Inventory Database for GCA and Egypt – to provide operational support in refining the existing emission inventory consisting of a point and area source inventory for GCA, a biogenic and geogenic inventory for Egypt and a UNFCCC compliant GHG inventory for Egypt to create a unified and comprehensive national inventory database that includes a mobile source inventory per the existing mobile source inventory development roadmap. The resulting unified database should enable policy tracking, international reporting, and chemical transport modeling. The data base structure should enable reporting interfaces that enable data reporting from various users (e.g., governorate level reporting of traffic and vehicle registration data, industrial reporting of point source emission data, etc.) to report data into the national system.

3. Development of an Integrated Climate and Air Quality Management Plan (IC-AQMP "Action" Plan)– to provide operational support to develop, assess, and evaluate policy options under a multi-level governance process to identify and justify elements of the GC Action Plan (including technical analysis, economic assessment and facilitation of consensus building process).

4. Development Curricula , Sustainable training at Local Universities and license system – to provide operational support for the development and roll-out of a new environmental resource management curriculum at GCA universities. The outcome should result in enhanced training and knowledge – at both the undergraduate and graduate level – around principles, basics and updates of environmental science, and AQM planning specifically, to ensure a pipeline of trained professionals for EEAA, as well as better prepared students to address other green skills development needed for Egypt as a whole. This should be planned in collaboration with University of Cairo, either alone or in partnership with Helwan University, and Aim-shams University, to ensure that Cairo is producing a steady supply of students with skills needed for environmental management and the green economy. In order to enhance the quality of the professional market of skilled professionals within Egypt, the Consultant should propose a rigorous international license and accreditation process.

5. Support Sustainable Development Within the Egyptian Government– to provide operational support to improve capacity of ministry staffs and sustainable development units - via executive skills training - to undertake integrated climate and air quality management planning and implementation of mitigation actions.

6. Implementation of Micro- and Macroeconomic Assessment of Action Plan– to provide operational support to provide a sector-specific detailed economic analysis of actions identified by IC-AQMP working group (see III above) comparing implementation costs against health, agriculture, and energy benefits of interventions, as well as macroeconomic benefits of reduced health spending, alternative patterns of investment and quality of life improvements, for labor force, tourism, recreation, etc.

7. Development of advanced Air Quality Forecasting system–to provide operational support to develop an enhanced AQ forecasting program (structured into a scoping and subsequent implementation phase) that builds on existing forecasting capacity for both poor air quality days and climatically extreme events. This work would likely involve an international vendor to provide support and training with local implementation partners who might carry on forecasting work at conclusion of project.

8. Development of AQ Public Awareness Website– to provide operational support to create a public information portal that provides access to information on (a) general background on air pollution/ public action (b) current conditions/AQ index and local observations and data and (c) forecasts with self-protective actions for public/ sensitive populations.

9. Establishment and Implementation Support for an Institutional Response Mechanism-to provide operational support to facilitate an intra-governmental stakeholder process to identify appropriate responses to declared "AQ Action Days" and implementation arrangements to be carried out by various government and private stakeholders (e.g., industries, schools, public health authorities, media, sensitive populations, etc.)

10. Provision of operational support for the newly developed source apportion (SA) monitoring network and chemical speciation analysis operated by EEAA/Cairo University -including knowledge transfer and capacity building for Egyptian colleagues as appropriate. This includes aspects of manual sampling, collection, transfer and storage, chemical speciation analysis, receptor modeling and reporting over calendar years 2023-2025, inclusive.