ABU DHABI STATE OF ENVIRONMENT REPORT 2017

AIR QUALITY

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Changes in air quality in Abu Dhabi Emirate are primarily brought about by population growth with a concomitant increase in demand for resources, as well as transport emissions. Emissions from industry and transport, as well as natural dust events, are a main cause of pressure on the quality of air in the emirate.

Air pollutants have a significant impact on human health in the emirate, as well as environmental, social and economic factors. Efforts to improve air quality are cross-sectoral, and include monitoring, regulations, enforcement, environmental planning, research and awareness, leading to a healthier environment and better quality of life.

Pollutants of major concern in Abu Dhabi Emirate are particulate matter and ozone. Sulphur dioxide levels are within UAE limits in most of the ambient air quality monitoring network, although an increase in concentrations has been observed over the past few years in the Al Dhafra Region. Hydrogen sulphide concentrations are not at harmful levels to the public, but frequent episodes of odour nuisance due to hydrogen sulphide have been recorded. Levels of nitrogen dioxide and carbon monoxide are below the limits set in the UAE air quality standard.

Good air quality is essential for the health and wellbeing of the population in Abu Dhabi Emirate and an intrinsic part of what makes it an attractive place to live and work. Therefore, for sustained growth in the emirate, it is crucial to maintain good quality air standards while pursuing economic development. Air pollution incurs costs associated with low employee productivity, healthcare, reduced agricultural yields, poor visibility that impacts transportation activities, and increased cleanliness and maintenance requirements of infrastructure.

Globally, air pollution is a major public health concern, particularly in urban areas where population density and pollutant concentrations are greatest. According to the UAE’s Environmental Burden of Disease Assessment [1], outdoor air pollution is the leading environmental cause of respiratory and cardiovascular diseases and medical visits in the UAE.

Air quality is a complex environmental issue. Air pollution may originate from man-made sources (such as industry and motor vehicles) or from natural sources (such as dust events). Air pollutants can be transported for long distances in the atmosphere, so that pollutants released in one country may contribute to or result in poor air quality elsewhere [2]. Abu Dhabi Emirate is working to improve its air quality within the framework of the UAE Vision 2021 [3] and Abu Dhabi Plan [4]. The leadership has a clear vision to monitor the emirate’s air quality and implement the most appropriate policies, regulations and incentives, collaborating with a wide range of public and private stakeholders.

Reducing outdoor air pollution also reduces emissions of carbon dioxide (CO$_2$) and short-lived climate pollutants, such as black carbon particles and methane, thus contributing to the near- and long-term mitigation of climate change [5].
3.1 State

The state of ambient air quality across the Emirate of Abu Dhabi is constantly monitored through an extensive network of monitoring stations (see Map 3.1).

Table 3.1 summarises the overall compliance and trend analysis of the main pollutants recorded in the ambient air quality network operated by EAD. The network comprises 20 fixed monitoring stations throughout Abu Dhabi Emirate, and two mobile monitoring units. It monitors up to 17 pollutants and select meteorological parameters on an hourly basis. Detailed information on the concentrations and number of exceedances per parameter and station are available through the EAD website (www.ead.ae/Pages/Green%20Business/air-quality.aspx), or directly from the Air Quality website (www.adairquality.ae).

Sulphur dioxide (SO₂)
Sulphur dioxide (SO₂) is a gaseous pollutant which is mainly emitted from fuel combustion in transportation, electricity production, water desalination and oil and gas processing. For the most part, SO₂ concentrations are within UAE limits. However, over the last few years, trends indicate a slight increase (see Figure 3.1) related to the increase of SO₂ concentrations registered in the Al Dhafra Region.

Carbon monoxide (CO)
Carbon monoxide (CO) is an atmospheric pollutant generated by internal combustion engines (including vehicles, ships and generators).

CO in Abu Dhabi Emirate is well within UAE air quality limits, and continuous improvements in engine efficiency have reduced its concentration in the air.

Nitrogen dioxide (NO₂)
Nitrogen dioxide (NO₂) is a gaseous pollutant mainly emitted during fuel combustion. In the past few years, NO₂ concentrations have remained stable and within UAE limits. However, continuous monitoring is required as the emirate’s increase in population and transportation usage may lead to an increase in NO₂ concentrations.

Ozone (O₃)
Tropospheric ozone (O₃), also referred to as ‘ground-level ozone’, is a secondary pollutant, which means it is not directly emitted from man-made or natural sources. It is formed in the atmosphere by photochemical reactions in the presence of sunlight and precursor pollutants, such as the oxides of nitrogen (NOₓ) and volatile organic compounds (VOCs).

Tropospheric ozone concentrations are currently above the UAE limits, with an observed gradual increase recorded over the past few years (see Figure 3.1). Due to the complexity of ozone formation, the main drivers of this increase have not yet been scientifically proven and are the subject of on-going investigation. In order to ascertain the main precursors of O₃ in the region, EAD is conducting a scientific project to improve knowledge about O₃ so as to propose policies and regulations to reduce tropospheric ozone.

Particulate Matter (PM₁₀)
Particulate matter less than 10 µm in diameter (PM₁₀) is the term for small solid or liquid particles found in the air. Their presence can be due to natural sources, such as sand from the desert, man-made sources, which are mostly combustion engines, or formed in the atmosphere when gaseous pollutants such as SO₂ and NOₓ react.

Background levels of PM₁₀ are significantly high in Abu Dhabi Emirate due to the arid nature of the region. Concentrations increase when dust events occur, transporting sand and dust into populated areas. The overall trend for PM₁₀ levels in the emirate shows stability in the values recorded over the past few years.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Compliance with UAE Standards</th>
<th>Trend (2007-15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide (SO₂)</td>
<td>Non-compliant</td>
<td>Increasing</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>Non-compliant</td>
<td>Non-compliant</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>Compliant</td>
<td>Non-compliant</td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>Non-compliant</td>
<td>Decreasing</td>
</tr>
<tr>
<td>Particulate Matter (PM₁₀)</td>
<td>Compliant</td>
<td>Stable</td>
</tr>
<tr>
<td>Hydrogen Sulphide (H₂S)</td>
<td>N/A</td>
<td>Stable</td>
</tr>
</tbody>
</table>

TABLE 3.1 Compliance with the UAE Standards and Trend Analysis per Pollutant

For more information on the concentration levels of the above pollutants, refer to the EAD Air Quality Monitoring Report (www.ead.ae/Pages/Green%20Business/air-quality.aspx).
years. This may be an indication of the significance of the high background levels due to natural sources of PM$_{10}$.

Particulate matter less than 2.5 µm in diameter (PM$_{2.5}$), also known as ‘fine particles’, is also a key pollutant that should be measured and analysed. This is due to the potentially adverse effects it can have on human health [6].

EAD has been measuring PM$_{2.5}$ since mid-2012, with the results showing values recorded above World Health Organisation (WHO) guidelines. At present, the UAE has not set standards for PM$_{2.5}$. However, EAD is working on a chemical speciation [7] and source apportionment project in order to determine the main contributors of PM$_{2.5}$ in the emirate. This aims to provide scientific knowledge that supports the development of a national standard and reduces PM$_{2.5}$ concentrations.

Hydrogen sulphide (H$_2$S)

Hydrogen sulphide (H$_2$S) gas has a characteristic odour of rotten eggs and can cause odour nuisance at very low concentrations [8]. Hydrogen sulphide is not considered a ‘criteria pollutant’ in the UAE; however it is monitored by EAD and is included in this report due to its importance to the population’s wellbeing. H$_2$S concentration measurements in Abu Dhabi Emirate are well within the threshold recommended by WHO. However there has been an increase in H$_2$S concentrations in certain specific areas, as well as in the number of odour complaints.

The main emission sources of H$_2$S in the emirate are the illegal dumping of solid waste and sewage, fugitive emissions from sewage distribution systems, wastewater treatment plants, and oil and gas activities.
Demographic factors, as described in Chapter 2 – Drivers of Environmental Change, play an important role in the pressure that is put on the environment, and air quality in particular, as a consequence of rapid infrastructure development, demand for water and electricity, transportation and land-use.

A significant amount of emissions in Abu Dhabi Emirate come from point sources, including facilities involved in oil and gas production and processing, electricity production, water desalination and industrial processes. Line sources, such as motor vehicle traffic and marine vessels, are also important contributors to the emirate’s total emissions (See Figure 3.4).

Observed trends in $SO_2$, $NO_2$, and $CO$ emissions are consistent with increases in electricity production, water desalination, motor vehicles and various industrial fuel combustion activities in Abu Dhabi Emirate. According to ambient air quality monitoring measurements, these pollutants generally remain within national limits. However, where road traffic is a significant contributor, exposure to pollution and impact on the public increases considerably. This is due to the concentration and proximity of these mobile sources to residential areas, commercial areas, schools and public spaces. This phenomenon must be considered and addressed by any abatement programmes.

Levels of $PM_{10}$ and $PM_{2.5}$ in Abu Dhabi Emirate frequently exceed the national standard limit values for the former and guideline values for the latter. Due to the arid climate and desert environment, Abu Dhabi Emirate experiences regular dust events throughout the year (see Figure 3.2 and Figure 3.3).

Although the emirate experiences high natural background levels of both of these pollutants, anthropogenic sources also contribute a substantial amount. Preliminary scientific studies show that a significant percentage of its precursors is from anthropogenic sources, including road traffic, shipping and industry [9]. Anthropogenic $PM_{10}$ is mainly caused by infrastructure development and construction activities, as well as by re-suspension on roads due to transport activities.
PM comes primarily from transportation. Most PM comes from natural sources.

NO₂: Almost half comes from transportation.

SO₂: Principally comes from power generation and distribution.

FIGURE 3.4 Sources of Air Pollution

SOURCE: EAD
3.3 Impacts

Health Impacts
Air pollutants can potentially have a serious impact on human health. According to the WHO, air pollution is the world's largest single environmental health risk (11). Globally, 3.7 million deaths are attributable to outdoor air pollution each year. There have been many epidemiological studies presenting the health impacts of air pollution (see Figure 3.5).

There are several environmental impacts caused by air pollution (9):
- Acid deposition, caused by NO₂ and SO₂, impacts buildings, water bodies, forests and wildlife.
- Eutrophication of water bodies can stimulate algal blooms and kill fish and plants.
- Tropospheric ozone, which damages vegetation.
- Negative impacts on wildlife caused by air pollutants.
- Short-lived climate pollutants which contribute to climate change.

Little is known about the potential of these impacts on the environment in Abu Dhabi Emirate. Further monitoring and research is required to better understand the local situation.

Social and Economic Impacts
Poor air quality also has a significant impact on socio-economic wellbeing in the Emirate of Abu Dhabi. Reducing air pollution would lead to a reduction in healthcare expenses and working days lost to health-related illnesses, as well as an increase in productivity levels in both public and private companies (12, 13, 14).

Environmental Impacts
There are several environmental impacts caused by air pollution:

- Impacts of eyes, nose and throat: breathing problems (O₂, PM, NO₂, SO₂).
- Cardiovascular diseases (PM, NO₂).
- Impacts on the respiratory system: irritation, inflammation and infections.
- Asthma and reduced lung function.
- Chronic obstructive pulmonary disease.
- Lung cancer (PM).

In the UAE, outdoor air pollution is a cause for concern in terms of its potential impact upon human health, as well as its associated healthcare costs. The primary pollutants of concern are PM and ground-level ozone (1). Health effects from other major pollutants (including NO₂, SO₂, H₂SO₄ and CO) are thought to be minimal, because local daily and annual average levels for these pollutants are mostly below UAE national limits.

![FIGURE 3.5 Health Impacts of Air Pollution](image)

3.4 Responses

The Emirate of Abu Dhabi has made efforts to improve ambient air quality and develop direct and strategic responses.

The Removal of Fuel Subsidies
To date, the UAE has taken important steps towards reducing fuel subsidies and deploying cleaner diesel to the domestic market. Further enhancing vehicle fuel efficiency and vehicle emission standards will do much to benefit air quality by reducing emissions of CO, NOₓ, and SOₓ.

Conversion of Government Fleet to Compressed Natural Gas (CNG)
In 2010, Abu Dhabi Executive Council adopted a decision to shift 25 % of vehicles in Government fleets to Compressed Natural Gas (CNG) by 2012. CNG has lower carbon content than diesel or gasoline.

Introduction of Ultra-Low Sulphur Diesel (ULSD)
The promotion of specific fuels must consider local conditions and lifecycle emissions levels. In July 2014, the UAE introduced ultra-low sulphur diesel, reducing sulphur content from 500 ppm to 10 ppm (15). This not only reduced sulphur emissions from diesel vehicles, but also allows for the introduction of advanced vehicle and emission control technologies that can further reduce PM and NOₓ vehicle emissions.

Promotion of Clean Vehicle Technologies
The Department of Transport (DOT) supports the growth of cleaner energy vehicles within its bus fleets. In 2015, 98 % of buses achieved Euro 4 standards, a European standard signifying the efficient use of diesel fuel. DOT also studied the integration of electric buses into its bus fleet.

Air Quality Monitoring Station Network
Given the rapid changes taking place in the Emirate of Abu Dhabi, from 2012 EAD expanded its network of air quality monitoring stations, adding 10 more across the emirate. Today, the EAD network (see Map 3.1) comprises 20 fixed air monitoring stations and two mobile stations, ensuring the continuous measurement of air quality across the emirate. The main objective is to provide accurate information and data on air quality in the emirate. This enables EAD and other concerned authorities to identify the drivers, pressures and state of the air quality, as well as to monitor the impacts of targeted management and policy responses.

Ambient Air Quality Electronic Linking (E-linking)
Ambient air quality is monitored through different regulatory authorities in Abu Dhabi Emirate. In 2014, EAD successfully linked several air quality monitoring networks in the emirate: the Abu Dhabi Water and Electricity Authority (ADWEA) and Higher Corporation for Specialized Economic Zones (ZonesCorp). With the support of the UAE Ministry of Climate Change and Environment (MOCCAE) to create a UAE-wide network, the National Center of Meteorology and Seismology (NCMS), and the Dubai Municipality networks were also linked.

The E-linked network provides more efficient and far wider coverage across Abu Dhabi Emirate and the UAE. In doing so, it provides a more holistic understanding of the quality of air across the emirates.
Compliance with Air Quality Standards and Regulations
Monitoring and reporting requirements are specified in environmental permits issued by EAD. They require owners and operators of certain facilities emitting air pollutants to regularly monitor ambient air quality in the vicinity of their facilities and to analyse their air pollutant emissions.

To assist both inspectors and regulated entities, EAD has developed standardised permit conditions for industrial and commercial facilities. The agency has also developed the Inspection and Compliance Tool (ICT), which includes general and sector-specific inspection questions to broaden the scope of environmental inspections and ensure consistency. In order to improve the environmental performance of targeted industrial sectors, EAD launched the Eltezam Environmental Campaign. Campaigns for the ready-mix concrete and fibre-glass sectors have already been successfully completed.

Research-based Air Quality Studies
EAD has initiated and executed a number of activities that have generated new knowledge about air quality. These include:
- PM$_{2.5}$ chemical speciation, source identification and apportionment.
- Ozone precursor monitoring, with the aim of collecting data to gain insight into anthropogenic and natural sources, as well as to understand the processes influencing ozone levels in Abu Dhabi Emirate.
- Mercury Emission Inventory and Emission Scenarios for Abu Dhabi, with the aim of providing emirate-wide estimates of natural and anthropogenic mercury emissions.
- The Abu Dhabi Air Emission Inventory, which compiles data and provides information about the air pollutants released to the atmosphere from different sources.

Energy and Water Efficiency Building Practices
An initiative developed by the Department of Urban Planning and Municipalities (DUPM), Estidama is an effective programme that incentivises the use of energy- and water-efficient construction materials and systems in new buildings. Such measures contribute to lowering the demand for resources, in turn reducing the need for additional power plants that would otherwise be sending emissions to air.

Industry
Abu Dhabi Emirate is working on a number of programmes to reduce the impacts of its industries on air quality.

EAD is developing sector-specific emission limits and promoting the connection of continuous emissions data from the major industries’ stacks to the agency in real time. A pilot project has been successfully completed with Umm Al Nar Power Plant, and more stacks will be connected in the near future.

It is important to highlight the great efforts made by many industries in the emirate to use the best available technologies, as well as their plans to continuously improve the efficiency of processes and reduce air pollution.

Transport
The Capital Surface Transport Master Plan, developed by DOT, provides the framework for an accessible and equitable transport system. It aims to encourage behavioural change in society and reduce vehicle-induced emissions.

Another key initiative is the Abu Dhabi Low Emission Vehicles (LEV) Strategy which will promote the introduction of the best low emission technologies into the private and public sectors.

However, existing inspection and maintenance protocols will have to be reviewed and improved to support the reduction of air pollution.

Research
More investigation is needed to further understand the role of poor air quality on the population’s health, and to enhance the mechanisms that reduce air pollution in the emirate. Abu Dhabi Emirate is leading this research with a large number of institutions investigating themes such as PM$_{2.5}$ speciation, ozone precursors, forecasting, and studying the relation between dust events and public health. This research is an important precursor to the development of regionally relevant air quality standards for parameters such as PM$_{2.5}$, where standards currently do not exist.

Research and investigation is an ongoing process continuously supported by Abu Dhabi Government. Furthermore, collaborative engagement between EAD, Health Authority – Abu Dhabi (HAAD), academia and the private sector is critical in improving scientific knowledge about air quality and the link between air pollution and health impacts, as well as providing the best tools and mechanisms to improve the air we breathe.

Awareness Campaigns and Educational Activities
Public acceptance and participation is an essential element for the successful implementation of air quality improvement programmes. Currently, there is little awareness among Abu Dhabi Emirate’s general population of air pollution problems. EAD has implemented targeted public awareness campaigns and educational activities, such as the annual Environ-spellation, the annual Environment Competition, the Sustainable Schools Initiative and Sustainable Campus Initiative.

Improving the information available to the general public and raising awareness levels in relation to air quality is essential for changing the behaviour of the population and empowering the community to take action for cleaner air.
3.5 Outlook

Looking Ahead
UAE Vision 2021 focuses on improving the quality of air, preserving water resources, increasing the contribution of clean energy and implementing green growth plans [3]. It has set a target of 90% of days to comply with the national standards for air quality.

Changing Course
A lot of effort has been made to achieve 2021 targets in Abu Dhabi Emirate, and many more measures will be implemented over the following years. This includes: a cross-sectoral approach to improve air quality in the emirate using the best technologies available; implementing the most suitable policies for regional conditions; extensive scientific investigation; and close cooperation between government entities and the private sector.

The national strategy to limit GHG emissions and mitigate climate change will also improve air quality in the emirate. This includes measures to increase the production of energy using renewable sources and increased efficiency in industries and the oil and gas sector. Additionally, Abu Dhabi Government is working on further actions that target the improvement of air quality in the emirate.

Provided all of the planned strategies and programmes continue to be implemented and advances in technology continue, it is anticipated that Abu Dhabi Emirate can continue to grow its population and economy while simultaneously minimising anthropogenic impacts on air quality.