Centre for Air Quality Management in Dakar (CGQA)

Presented by Aminata Mbow DIOKHANE
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Centre for Science and Environment
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Senegal is located in the western most part of Africa’s Sahel region.

- national territory spanning is 196,722 km²,
- population is estimated at 13.5 million,
- 50% of which live in urban zones.
Senegal overview

Senegal is bounded by:
✓ Atlantic ocean in west:
✓ Mauritania in north and east;
✓ Mali in east;
✓ Guinea and Guinea Bissau in south

Capital city is Dakar
Senegalese Government:

- being aware of the need to improve the quality of life of people;
- taking into account the impacts of air pollution on the human health and the environment (the health cost of air pollution is estimated at 65 billion in 2001 according to a study of the World Bank);
- created in 2009 a Centre for Air Quality Management (CGQA) which is so far, the only one in west Africa.
Background and justification

The centre is funded by the Nordic Development Fund (NDF) and the Senegalese Government.

The setup was done through the fourth component of the PAMU (Urban Mobility Improvement Programme) implemented by the ministry of transport and which consisted of the creation of:

1. Centre for Air Quality management (Centre de Gestion de la Qualité de l’Air – CGQA);
2. Motor Vehicles Technical Control Centre (Centre de Contrôle Technique des Véhicules Automobiles – CCTVA)
Due to its objectives of environment watch, the centre has been placed under the supervision of the Ministry of Environment and Sustainable Development.

It has five monitoring stations and a reference laboratory.
Objectives

✓ keep on watching the ambient air pollution,

✓ Inform the public on air quality and provide reports to the authorities for decision making,

✓ Advocate realistic measures for improving air quality,

✓ Promote the establishment of a committee on air quality
### Pollutants monitored by CGQA (1)

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Source</th>
<th>Health effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>Combustion sources, refineries, coal combustion</td>
<td>Cough, breathlessness, asthma, irritating gas for skin mucous and upper respiratory system</td>
</tr>
<tr>
<td>Nitrogen oxides (NOₓ)</td>
<td>Vehicles, combustion sources, coal burning stoves</td>
<td>Irritating gas to the bronchi, child lungs infections</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>Vehicles, industries, open burning (incomplete combustion)</td>
<td>Chronic intoxication, headaches, vertigo, asphyxia, cardiovascular problems</td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>Chemical processes formed from other pollutants (VOC, NOx) in presence of sunlight</td>
<td>Cough, eye irritation</td>
</tr>
</tbody>
</table>
### Pollutants monitored by CGQA (2)

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Source</th>
<th>Health effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter (PM$<em>{10}$ and PM$</em>{2.5}$)</td>
<td>diesel engines, power plants, industries, wind blown dust, combustion sources, mines, unpaved roads.</td>
<td>Respiratory and cardiovascular diseases, PM can be combined with toxic and even carcinogenic substances like heavy metals</td>
</tr>
<tr>
<td>Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)</td>
<td>Incomplete combustion, solvents (paints, varnishes, ink…), cleaning products, fuel</td>
<td>Benzene, the most toxic, acts on the nervous and blood system. Toluene, Ethylbeneze and Xylene are irritating to the skin and mucous (eye and respiratory problems).</td>
</tr>
</tbody>
</table>
How we measure air quality?

- Continuous measurement
  - Fixed monitoring stations with ambient air analyzers
  - Mobile laboratory with analyzers which enable to measure in areas not covered by the fixed stations
How we measure air quality?

Analyzers inside the station

- Continuous measurement

  - Gaz analyzers that determine pollutants concentrations using a spectroscopic method

  - Real time data: instant alert possible

  - Measurement campaigns when integrated to the van
How we measure air quality?

- Discontinuous measurement
  - Passive samplers placed for at least 15 days, then analyzed at laboratory
  - Measurement campaigns
Location of the stations

Sampling sites
Locations of the stations

Sampling sites and stations location

Air quality measurement sites in Dakar

- Monitoring stations
- Sampling sites
Location of the stations
5 monitoring stations around the city of Dakar
## Location of the stations

**Station type and monitored pollutants per station**

<table>
<thead>
<tr>
<th>#</th>
<th>Site name</th>
<th>Coordinates</th>
<th>Station type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>W</td>
</tr>
<tr>
<td>1</td>
<td>Bd. Republique</td>
<td>14deg 40' 14&quot;</td>
<td>17deg 26'11&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Medina</td>
<td>14deg 41'14&quot;</td>
<td>17deg 26'54&quot;</td>
</tr>
<tr>
<td>3</td>
<td>HLM4</td>
<td>14deg 42'37&quot;</td>
<td>17deg 27'09&quot;</td>
</tr>
<tr>
<td>4</td>
<td>BelAir</td>
<td>14deg 40'50&quot;</td>
<td>17deg 25'58&quot;</td>
</tr>
<tr>
<td>5</td>
<td>Yoff</td>
<td>14deg 44'51&quot;</td>
<td>17deg 27'35&quot;</td>
</tr>
</tbody>
</table>

### Parameters

<table>
<thead>
<tr>
<th>Site</th>
<th>Site</th>
<th>SO2</th>
<th>NOx</th>
<th>NO2</th>
<th>PM10</th>
<th>PM2,5</th>
<th>O3</th>
<th>CO</th>
<th>Benz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bd. Republique</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>Medina</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
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<td>3</td>
<td>HLM4</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>BelAir</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>Yoff</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Location of the stations

Meteorological parameters are measured at HLM station

- Temperature
- Relative humidity
- Net radiation
- Pressure
- Wind speed
- Wind direction
Data transfer system

Flow diagram for data transfer from XRPremium to AirQUIS at CGQA Office

Export from XR Premium
- Daily export of automatic validated data
- Monthly export of Quality controlled data
- All data are in scaled and correct unit converted condition

Import to AirQUIS
- Every hour automatic import
- Import the content of the predefined ascii-files in the predefined shared folder
Air Quality Index (AQI)

✓ Index for reporting daily air quality on the web www.air-dakar.org;

✓ Tells how clean or polluted the air is, and what associated health effects might be a concern;

✓ Five pollutants are used to calculate the AQI: O₃ (ozone), PM (particulate matter), CO (carbon monoxide), SO₂ (sulphur dioxide) et NO₂ (nitrogen dioxide).
# Air Quality Index (AQI)

**AQI = Air Quality Index**

The AQI index is for reporting daily air quality:
- how clean or polluted is the air,
- indicate associated health concerns you should be aware of.

<table>
<thead>
<tr>
<th>Air Quality Index (AQI) values…</th>
<th>Levels of Health Concern</th>
<th>Colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the AQI is in this range…</td>
<td>… air quality conditions are:</td>
<td>… as symbolized by this color:</td>
</tr>
<tr>
<td>0 – 50</td>
<td>Good</td>
<td>Green</td>
</tr>
<tr>
<td>51 - 100</td>
<td>Moderate</td>
<td>yellow</td>
</tr>
<tr>
<td>101 - 200</td>
<td>Unhealthy</td>
<td>Orange</td>
</tr>
<tr>
<td>&gt; 200</td>
<td>Very Unhealthy</td>
<td>Red</td>
</tr>
</tbody>
</table>

The AQI is calculated using the formula:

\[
AQI = \frac{\text{Pollutant concentration}}{\text{Pollutant limit value}} \times 100
\]
### Air Quality Index (AQI)

**Guidelines and limit values (µg/m³)**

**WHO & Senegal**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging time</th>
<th>Maximum Limit Value</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>WHO</strong></td>
<td></td>
<td><strong>Senegal</strong></td>
</tr>
<tr>
<td>Sulphur Dioxide (SO₂)</td>
<td>1 hour</td>
<td>500 (10 min)</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>24 hours Year</td>
<td>125</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO₂)</td>
<td>1 hour</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>40-50</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Ozone (O₃)</td>
<td>1 hour</td>
<td>150-200</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>8 hours</td>
<td>120</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>1 hour</td>
<td>30 000</td>
<td>30 000 (24h)</td>
<td>30 000 (24h)</td>
</tr>
<tr>
<td></td>
<td>8 hours</td>
<td>10 000</td>
<td></td>
<td>30 000 (24h)</td>
</tr>
<tr>
<td>Particles &lt;10 µm (PM10)</td>
<td>24 hours Year</td>
<td>50 *</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>20 *</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>Year</td>
<td>0.5-1,0</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Other reports

Reports on air quality

- Monthly reports
- Quarterly reports
- Annual reports

Available for download on the following websites:

www.air-dakar.org

www.denv.gouv.sn
Air Quality Index (IQA)

Episode of air pollution on 27 February to 1st March 2015 - Alert message was sent

Episode of poor air quality started on 26 February due to high PM concentrations, is going on.

Children, people with asthma and other chronic lung diseases, the elderly, should remain vigilant and contact a physician if needed.

Source: Ministère de l'Environnement et du Développement Durable / DEEC / CGQA 27 février 2015
Air Quality Index (IQA)

Episode of air pollution on 27 February to 1st March 2015 - Alert message was sent

The whole city (and even the country) has been covered by dust that caused a problem of visibility
Where the pollution comes from?

- Saharan dust is also correlated with episode of high PM concentrations
- Car traffic during these episodes become obviously another aggravating factor
Very unhealthy air quality during late February 2015

Maximum of daily average concentrations for PM$_{10}$ (1000 µg/m$^3$) exceeded 3 times the senegalese limit value and 20 times the WHO limit value on 27 February 2015.
The highest PM$_{2.5}$ value (232 µg/m$^3$) was also measured on the same date (27 February). It exceeded 9 times the WHO limit value.
The evolution of the AQI in 2014

Seasonality of air pollution

Daily AQI evolution in 2013

- Très Mauvais
- Mauvais
- Moyen
- Bon
The Evolution of the AQI from 2010 to 2013

Seasonality of air pollution

Evolution of the AQI from 2010 to 2013

- Très Mauvais
- Mauvais
- Moyen
- Bon

2010 2011 2012 2013
Episodes of pollution in 2014

PM$_{10}$ January 2014

✓47% of daily PM$_{10}$ average concentrations exceeded the NS-05-062 limit value
Episodes of pollution in 2014
January 2014

27 days at Bel Air station

More than 90% of observations has exceeded the limit value
Good air quality during the rainy season

PM Concentrations decrease on August

No limit value exceedance during the rainy season
Origin of pollution

Where the pollution comes from?

- Industrial area (nord-east)
- Fishing warf in the harbour (west)
- Road traffic (south)

SO₂ Breur Diagram first quarter 2013
Impact of traffic

Diurnal PM$_{2.5}$ evolution in 2013

PM$_{2.5}$ diurnal variation in 2013

Concentrations pics during traffic jam hours
Impact of traffic

Diurnal variation of carbon monoxide

✓ Traffic station located on the road side

✓ Maximum values observed during hours of traffic jam

CO diurnal variation during 2013 first quarter
Impact of traffic
Nitrogen dioxide (NO₂) diurnal variation in January 2014

Pics of concentrations during the traffic jam hours
Automobile exhaust gaz measurement

In collaboration with the Motor Vehicles Technical Control Centre (CCTVA)

✓ Sampling of vehicles emissions during the phase of preparation of PATMUR (Transport and Urban Mobility support project) implemented by the ministry of transport and which is the second stage of PAMU,

✓ Determine traffic_related air pollution
Automobile exhaust gaz measurement

Measurement of the key traffic pollutants

✓ Carbon monoxide (CO)
✓ Carbon dioxide (CO₂)
✓ Oxygene (O₂)
✓ Nitrogen monoxide (NO)
✓ Hydrocarbures (HC)
✓ Opacity (diesel car).
Automobile exhaust gas measurement

NOx concentrations for diesel cars
Automobile exhaust gaz measurement

NOx concentrations according to vehicles ages
Automobile exhaust gas measurement

\( CO \) concentrations for petrol vehicles
Automobile exhaust gaz measurement

CO concentrations according to vehicles ages
Automobile exhaust gaz measurement

Concentrations $CO_2$ for petrol vehicles
Automobile exhaust gas measurement

$CO_2$ concentrations for petrol vehicles

French standards are used as limit value
Other initiatives for improving urban mobility

**PAMU project achievements**

Building of new road and infrastructure,

Building and refurbishment of public transport (buses, taxis) station,

Building of railway infrastructure,

Campaigns for road safety,

Renewal of the old buses,

Capacity building for urban transport stakeholders
Improving urban mobility

Building of new road and infrastructure
Improving urban mobility

Building of new roads and bus terminals, road safety enforcement
Improving urban mobility

Capacity building for urban transport stakeholders
Improving urban mobility

Replacement of 937 of « cars rapides » and « Ndiaga Ndiaye » in a total of 2500 old buses. Ongoing ...
Improving urban mobility

New buses to replace the old
Conclusion

PM = major pollutant in Dakar

Potential sources:

- Dust from Sahara
- Vehicles
- Building of roads and infrastructure
Conclusion

For a better air quality assessment and abatement strategies

- Particles chemical sampling to evaluate the pollution caused by traffic;

- Assessment of emissions from motorized vehicles and industrial facilities.
Conclusion

For a better air quality assessment and abatement strategies

✓ Likange between epidemiological data do (rate of hospital admissions, respiratory diseases frequency) with episodes of pollution to better evaluate the morbidity and the mortality from air pollution
Thank you for attention

www.air-dakar.org

www.denv.gouv.sn