Strategies for Clean Air and Bright Sky in Tainan

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Where is Tainan City?

Area: 2,191 km²
Population: 1,880,000
Environmental Load

- **Construction Site**: 27.3%
- **Automobile**: 19.6%
- **Diesel Vehicle**: 15.3%
- **Factory**: 5.9%
- **Population**: 0.7%
- **Scooter**: -2%

- **PM$_{10}$**: -42.4%
- **PM$_{2.5}$**: -23.2%

The chart illustrates the environmental load from various sources over the years 2007 to 2018.
Influence of Meteorology on Air Quality

Meteorology and topographical factors lead to pollutant retention.

Vehicle Exhaust Pollution

• Total vehicles is 1.98 million.
• 1.05 vehicles per citizen.

Traditional Activity and Agricultural Pollution

• Total temples are over 2000.
• Joss paper and incense sticks burning.
• Agricultural waste burning.
Influence of Meteorology on Air Quality

Stationary Zone

Wake Effect Zone
Topographical and Pollution

- Northeast monsoon blows during fall to spring.
- Located on the leeward side and the weak wind tail zone.
- Pollutants are difficult to diffuse.

### PM$_{2.5}$ Concentration

- **Rainy Season & Blows Southwest Monsoon**

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>µg/m$^3$</td>
<td>38.8</td>
<td>36.8</td>
<td>36.9</td>
<td>28.6</td>
<td>18.5</td>
<td>10.6</td>
<td>12.9</td>
<td>12.8</td>
<td>19.8</td>
<td>30.0</td>
<td>33.2</td>
<td>34.0</td>
</tr>
</tbody>
</table>

Tainan
### The Major PM$_{2.5}$ Sources

#### Primary PM$_{2.5}$

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory</td>
<td>17.1%</td>
</tr>
<tr>
<td>Diesel Vehicle</td>
<td>[值]</td>
</tr>
<tr>
<td>Bare Surface</td>
<td>[值]</td>
</tr>
<tr>
<td>Construction Site</td>
<td>9.2%</td>
</tr>
<tr>
<td>Road Dust</td>
<td>9.1%</td>
</tr>
<tr>
<td>Agricultural Operation</td>
<td>8.4%</td>
</tr>
<tr>
<td>Catering</td>
<td>6.8%</td>
</tr>
<tr>
<td>Automobile</td>
<td>6.2%</td>
</tr>
<tr>
<td>Scooter</td>
<td>5.9%</td>
</tr>
<tr>
<td>Agricultural Burning</td>
<td>3.9%</td>
</tr>
<tr>
<td>Other</td>
<td>5.7%</td>
</tr>
</tbody>
</table>

#### Secondary PM$_{2.5}$

- Chemical Material Manufacturing, 24%
- Textiles Mills, 12%
- Basic Iron and Steel Manufacturing, 9%
- Paper Products and Printing Manufacturing, 5%
- Other Business, 6%
- Other, 34%
- Other, 18%
- Chemical Material Manufacturing, 5%
- Energy Manufacturing, 5%
- Scooter, 6%
- Automobile, 13%
- Diesel Vehicle, 53%
- Other Business, 6%
- Chemical Material Manufacturing, 5%
- Energy Manufacturing, 5%
- Other, 18%
- Chemical Material Manufacturing, 5%
- Energy Manufacturing, 5%
- Other, 34%

Source: TEDS 9.0 (Base year: 2013)
02

Major Air Pollution Control Strategies
Clear & Bright Sky Plan

- 18 bureaus of Tainan city worked together to promote 9 strategies and 50 items in 2018.

2014
8 Strategies
25 Items

2015
9 Strategies
37 Items

2016
9 Strategies
42 Items

2017
9 Strategies
45 Items

2018
9 Strategies
50 Items

2019
Rolling Review

9 Strategies
50 Items

1. Road dust reduction
2. Construction control
3. Factory control
4. Reduce emission of diesel vehicles
5. Reduce emission of scooters
6. Fugitive emission control
7. Reduce Bare Surface
8. Promote low-emission mobility
9. Environmental education

2014
8 Strategies
25 Items

2015
9 Strategies
37 Items

2016
9 Strategies
42 Items

2017
9 Strategies
45 Items

2018
9 Strategies
50 Items

2019
Rolling Review
Methods of Factory Control

Control Sources of Pollution - Use less toxic raw materials or fuels
Economic Incentives - Air Pollution Control Fees
Enhance Control Technology/Equipment
- IBACT (Individual Best Available Control Technology)
- BARCT (Best Available Retrofit Control Technology)
The aim is reducing the unhealth of air quality.

Reduction plan and incentives of reduction fall to spring.
The density of air quality monitoring device is 2.1 km²

- **6 Auto-monitoring stations**
  (4 EPA + 2 Tainan EPB)

- **4 Auto-monitoring stations in industrial zones**
  (Southern Taiwan Science Park)

- **12 Manual operation monitoring stations**
  (Tainan EPB)

- **13 Continuous Emission Monitoring Systems**
  (Factories)

- **220 Air boxes**
  (Non-governmental)

- **900 Air quality microsensors**
  (Tainan EPB)
Vehicle Exhaust Background

- 1.05 vehicles per person in Tainan.
- Produced 17,338 tons of NOx emission and 1,622 tons of PM$_{2.5}$ yearly.
Emission Controls on Scooter

1. Road Site Inspection
2. Encourage Citizen to Blow the Whistle
3. Funded Strategy
4. License Plate Recognition
5. Restrictive Legislation

NO Entry
Decreasing Two-stroke Scooter and Increasing E-Scooter

Two-stroke scooters were decreased by 350 thousand vehicles in 7 years.

Electric scooters were increased more than 33,652 in 7 years.
Emission Controls on Diesel Vehicles

Setting 14 Clean Air Zones - Where car needs a badge to enter

- Subsidy for eliminating old vehicles
  - 2015
  - 2016
  - 2018
  - 2019

- Low Emission Zone - Restrict Vehicles Entry
E-Vehicles Schedule

- **2030**: All buses and officials use electric vehicles
- **2035**: All e-scooters
- **2040**: All e-vehicles
Traditional Activity

Pollutions from cultural activities

- Tainan has the most temples in Taiwan (more than 700 temple fairs every year).

Pollutants from Joss Paper

Pollutants from Incense Sticks

Pollutants from Firecrackers
Emission Controls on Joss paper

Donating Money Instead of Purchasing Joss Paper

Incineration just for Joss Paper

Amount of Donation (NTD)

64 Times

Transported 9,102 tons in the last eight years.
Reducing 30 tons of TSP emission from burning joss paper and incense sticks during 2011 to 2018.
Agricultural Waste

Solving waste pollution from agriculture

- Producing **150 thousand tons of rice straw** and **2,800 tons of waste shells** every year.
- After harvest, lots of waste will be produced and burned causing air pollution.

Burning Waste Rice Straw  
Waste Water-caltrop Shells
Straw Blankets

Buried on Site
It can improve **soil infertility, fertilize land**, help agricultural resources recycling and reduce waste of natural resource.

Process
Recycled waste is used in additional processes as new products, such as straw blankets to cover the bare surface, or the water-caltrop shells into incense sticks.

Reuse
Waste reuse, such as straw stalks directly cover the orchard.
In Tainan, producing 2,100 tons of waste shells every year. However farmers usually throw or burn it in the open field. Therefore, making the waste shells into **biochar** and using in **variety of products**.

1. Collecting
2. Dried
3. Carbonized
4. Biochar

**Circular Economy - Biochar**

- Deodorizer
- Biochar teacup
- Biochar Dye

**Carbonized water-caltrop shell**
The Results of Air Quality Improvement
Reduce PM$_{10}$ and PM$_{2.5}$

PM$_{10}$

- Reached to air quality standard for 4 years.
- PM$_{10}$ annual average decreased by 24%
- PM$_{10}$ daily average decreased by 29%

PM$_{2.5}$

- PM$_{2.5}$ annual average decreased by 34%
- PM$_{2.5}$ daily average decreased by 31%
The Goal

Increase the day of blue sky

Reduce the day of "unhealthy" air

Increase by at least 2% annually

Reduce days with AQI 151-155

AQI 0-100 (ratio)

2014: 60%
2015: 69%
2016: 70%
2017: 72%
2018: 76%
2019: 78%

AQI 151-155
2014: 42
2015: 48
2016: 58
2017: 38
2018: 25
2019: 30

AQI 156-160
2014: 92
2015: 110
2016: 110
2017: 38
2018: 25
2019: 30

AQI >161
2014: 119
2015: 119
2016: 110
2017: 43
2018: 36
2019: 30

Reduce the day of "unhealthy" air

Increase the day of blue sky
Conclusion

We are Breathing the Same Air
Thanks for your attention