On-Road Emissions in Asia Measured by Remote Sensing.

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- [www.feat.biochem.du.edu](http://www.feat.biochem.du.edu)
- [www.sign.du.edu](http://www.sign.du.edu)
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Web sites

- [www.feat.biochem.du.edu](http://www.feat.biochem.du.edu) DU reports, publications and downloadable data.
- [www.sign.du.edu](http://www.sign.du.edu) SMART SIGN 24/7 RSD operation and live web camera.
- [www.rsdaccuscan.com](http://www.rsdaccuscan.com) ESP Accuscan web site.
The on-road advantage

• Large on-road emissions cause poor air quality.
• Remote sensing measures on-road emissions.
• Mass emission per unit of fuel consumed.
Asia results

- On road emissions measured in Asia show large geographic variability and that a few vehicles are responsible for most of the on-road emissions.
- Emission benefits from new technology are everywhere apparent.
- Emission benefits from I/M programs are difficult to discern.
<table>
<thead>
<tr>
<th>Locations &amp; Year</th>
<th>Measurements</th>
<th>Mean gCO/kg</th>
<th>Mean gHC/kg</th>
<th>Mean gNO/kg</th>
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<td>Bangkok THA, 1993</td>
<td>5,260</td>
<td>264</td>
<td>220</td>
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<td>Petrol 2003</td>
<td>8,544</td>
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<td>Hong Kong, 1993</td>
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<td>11,227</td>
<td>362</td>
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<td>Kuala Lumpur MAL, 1995</td>
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<td>149</td>
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<td>New Delhi, India, 2004</td>
<td>10,208</td>
<td>142</td>
<td>48</td>
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<td>Sri Lanka, 2004</td>
<td>35,000/6,659/14,944</td>
<td>66/209/16</td>
<td>50/61/17</td>
<td>11/15/7</td>
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<td>Auckland NZ, 2004</td>
<td>34,400</td>
<td>89</td>
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<td>10</td>
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<td>Average USA 1989-92</td>
<td>34,000</td>
<td>113</td>
<td>26</td>
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<tr>
<td>Average USA 2003</td>
<td>63,000</td>
<td>39</td>
<td>3.5</td>
<td>4.9</td>
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</table>
gm/kg CO 2003/2004

Mass Emission gm/kg of fuel

- **Japan**
- **Singapore**
- **Sri Lanka**
- **New Delhi**
- **Denver**
NO gm/kg autos only

mass emissions gm/kg of fuel

Japan | Singapore | Sri Lanka | New Delhi | Denver

NO gm/kg

top 10%
Asia comparison

• Some locations in Asia, Singapore, Hong Kong and Tokyo in particular, demonstrate on-road emissions comparable to current U.S. on-road fleet averages.
• Most of the emissions come from a few on-road vehicles
• The gross emitters
• Two-stroke vehicles are inevitably in this category
Auto emissions by decile. New Delhi, 2004
A few gross emitters

- It is apparent from this diagram that there is a majority of cars with negligible emissions, while the average is dominated by a very small fraction of the fleet.
Diesel vehicle smoke increases steadily with age.

Petrol vehicles have less smoke but smoke also increases with age.

A smoke reading of 1.0 corresponds to approximately 10 gm of smoke/kg of fuel. BAD!
Singapore RSD - Smoke - Diesel

Average Smoke

- HGV - D
- BUSES - D
- LGV - D
- TAXIS - D
• On-road emissions are not the same as readings from scheduled emission tests.
• On average the two correlate very well. CO, HC, NO and smoke versus IM240 $r^2 > 0.95$ Pokharel et al 2000. CRC poster available at [www.feat.biochem.du.edu](http://www.feat.biochem.du.edu) and Vancouver report.
• On-road gross emitters pulled over by a policeman have more than an 85% chance of failing a California emissions test.