



Air Pollution and Environmental Health Threats in Southern China

Christine Loh

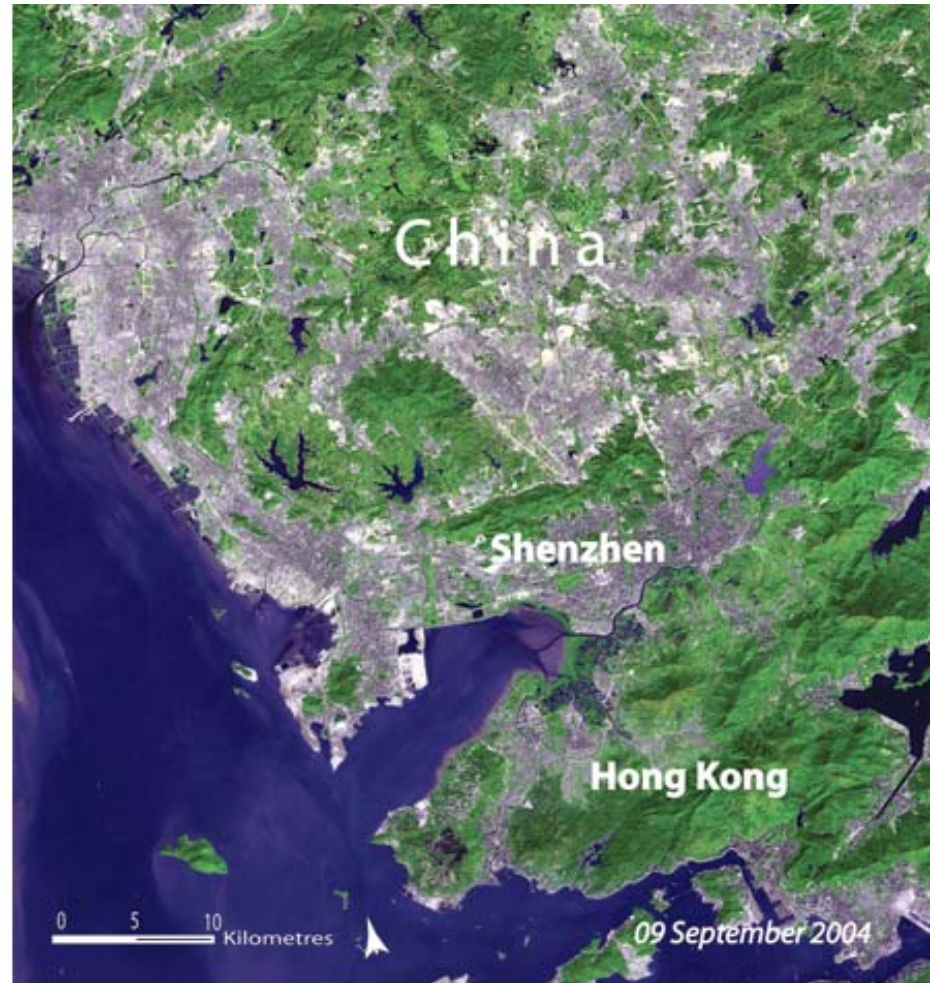
China Environment Forum, Woodrow Wilson Center

13 February 2007

Rapid Urbanisation Hong Kong & the Pearl River Delta

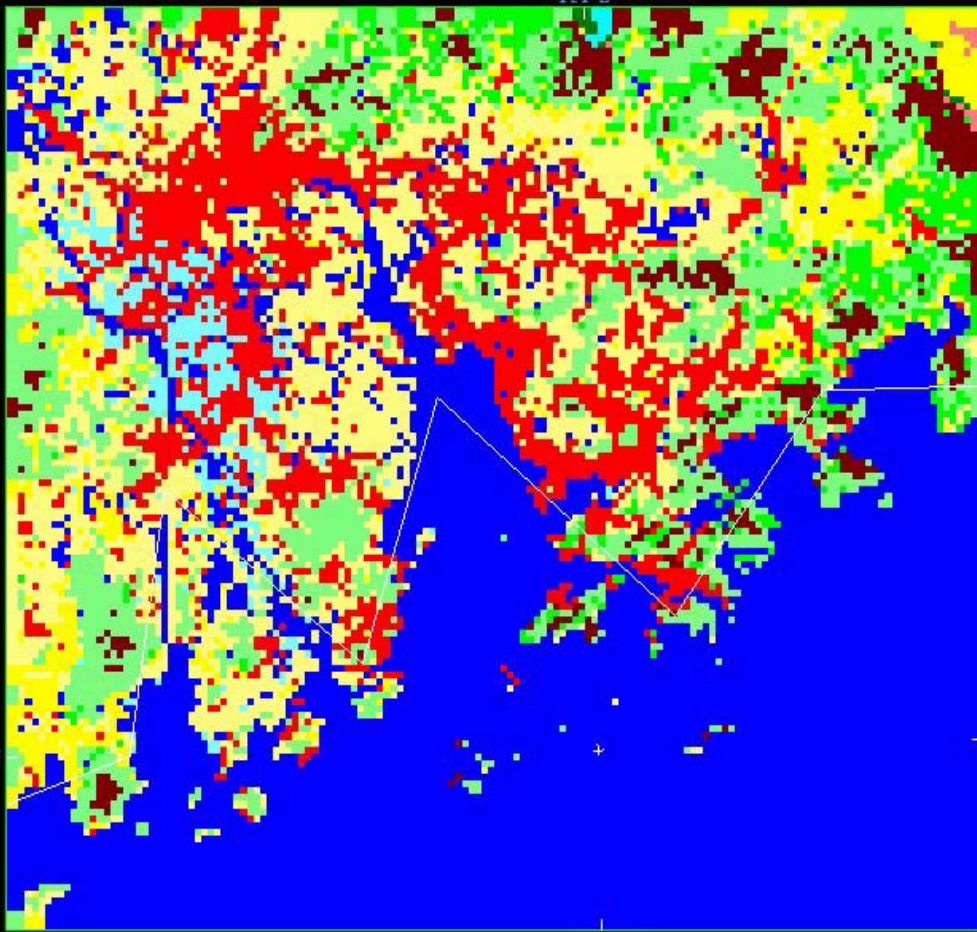


1979

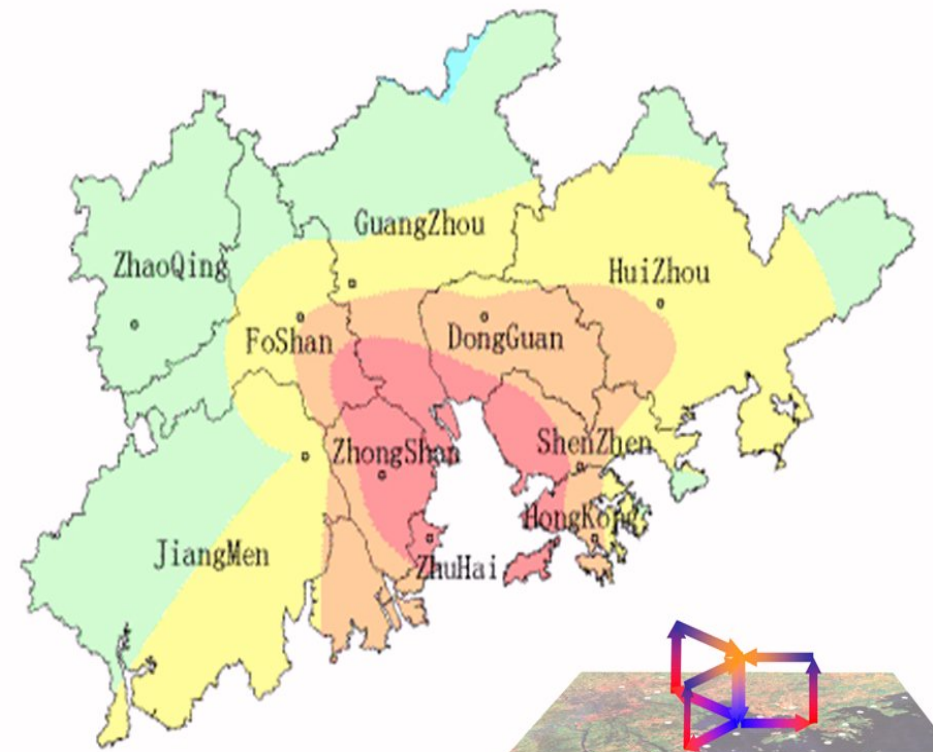


2004

Urban land sea-breeze circulation leads to enhanced trapping of pollutants over PRD



Pearl River Delta Regional Air Quality Map
2006. 03. 16



Percentage contribution for HK	Regional sources	HK sources
Ambient PM	~ 80%	~ 20%

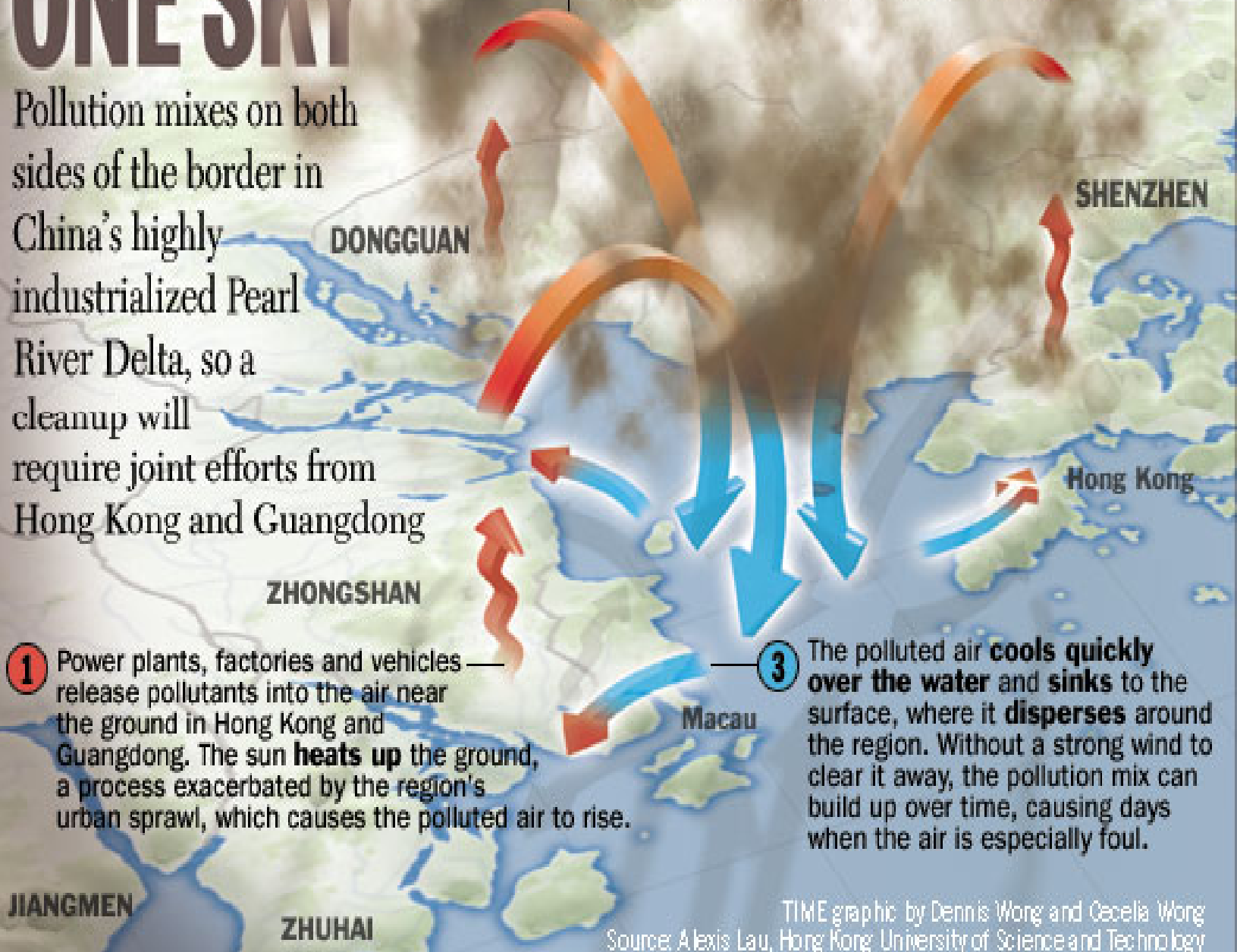
One Country ONE SKY

Pollution mixes on both sides of the border in China's highly industrialized Pearl River Delta, so a cleanup will require joint efforts from Hong Kong and Guangdong

1 Power plants, factories and vehicles release pollutants into the air near the ground in Hong Kong and Guangdong. The sun **heats up** the ground, a process exacerbated by the region's urban sprawl, which causes the polluted air to rise.

2 Local winds **push** the polluted air from Hong Kong and Guangdong toward the mouth of the Pearl River Delta, where pollution from both sides of the border **meet** and **mix**.

3 The polluted air **cools quickly over the water** and **sinks** to the surface, where it **disperses** around the region. Without a strong wind to clear it away, the pollution mix can build up over time, causing days when the air is especially foul.



What's in the Air

Sulfur Dioxide

CAUSES: coal-burning power plants and heavy industry
EFFECTS: reduces lung function, exacerbates wheezing and shortness of breath

Nitrogen Dioxide

CAUSES: vehicle emissions and power plants
EFFECTS: helps form smog, exacerbates asthma and increases chances of respiratory infections

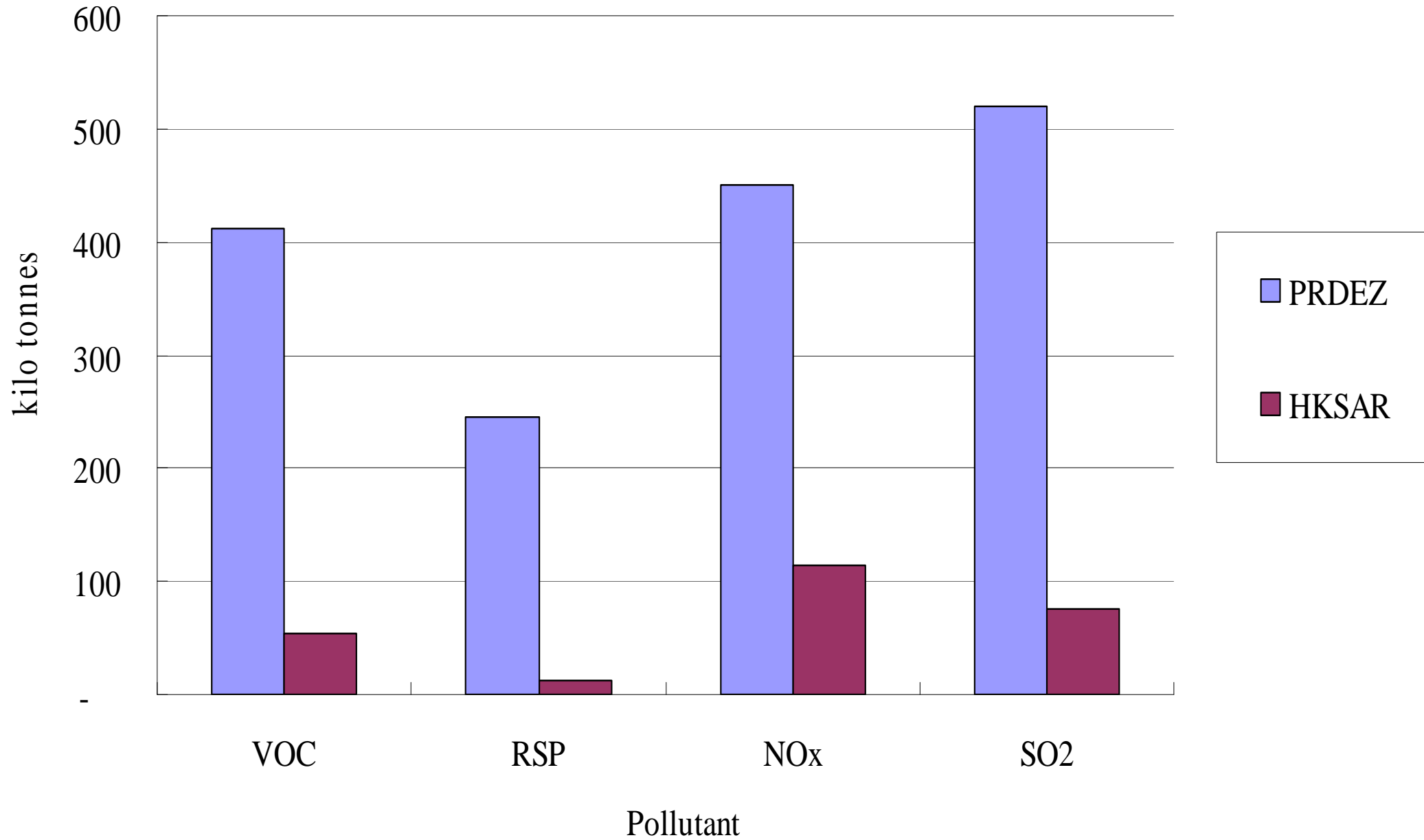
Respirable Suspended Particulates

CAUSES: these tiny particles are created chiefly by diesel exhaust and coal-burning power plants
EFFECTS: can penetrate deep into lungs and aggravate serious respiratory and cardiovascular diseases

Ozone

CAUSES: formed by the reaction in sunlight of volatile organic compounds that primarily come from cars
EFFECTS: causes chest pain and coughing, aggravates asthma

Emissions: PRD and Hong Kong (1997)



Regional Air Quality – A Closer Look

1. Total emissions by inventory

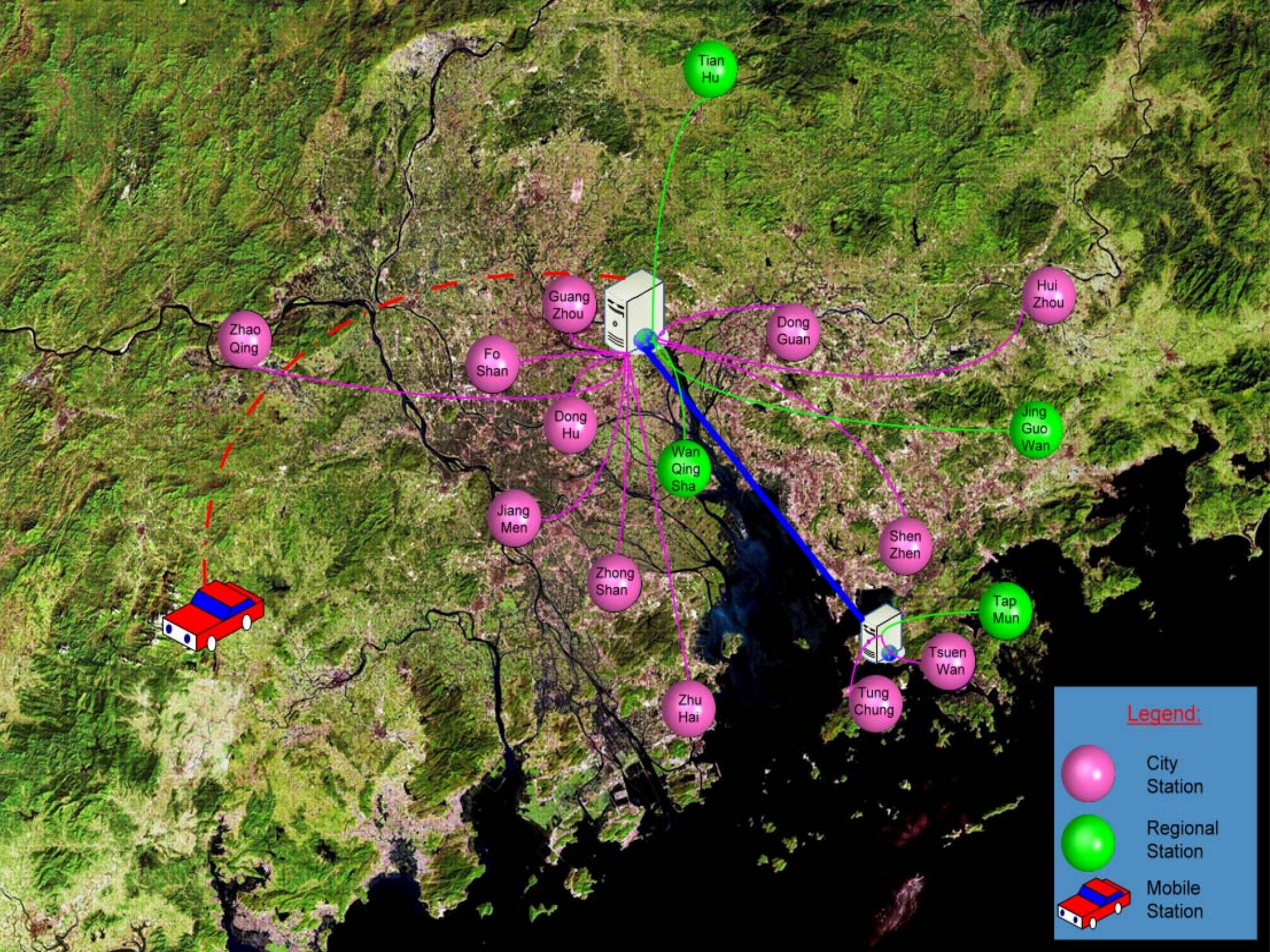
- 80% vs. 20%

2. Source apportionment at AQMS

- 60%-70% vs. 30%-40%

3. Number of days affected

- Subject of new research
 - Air Quality data from 14 AQMS
 - Data from HK/PRD Regional Network
 - Wind data from HK Observatory
 - Speciated elemental data from 24-hour samples collected at 10 AQMS
 - Satellite Aerosol Optical Depth Information



Legend:

-  City Station
-  Regional Station
-  Mobile Station

Zhao Qing

Fo Shan

Dong Hu

Jiang Men

Zhong Shan

Zhu Hai

Guang Zhou

Wan Qing Sha



Dong Guan

Shen Zhen

Tung Chung

Tsuen Wan

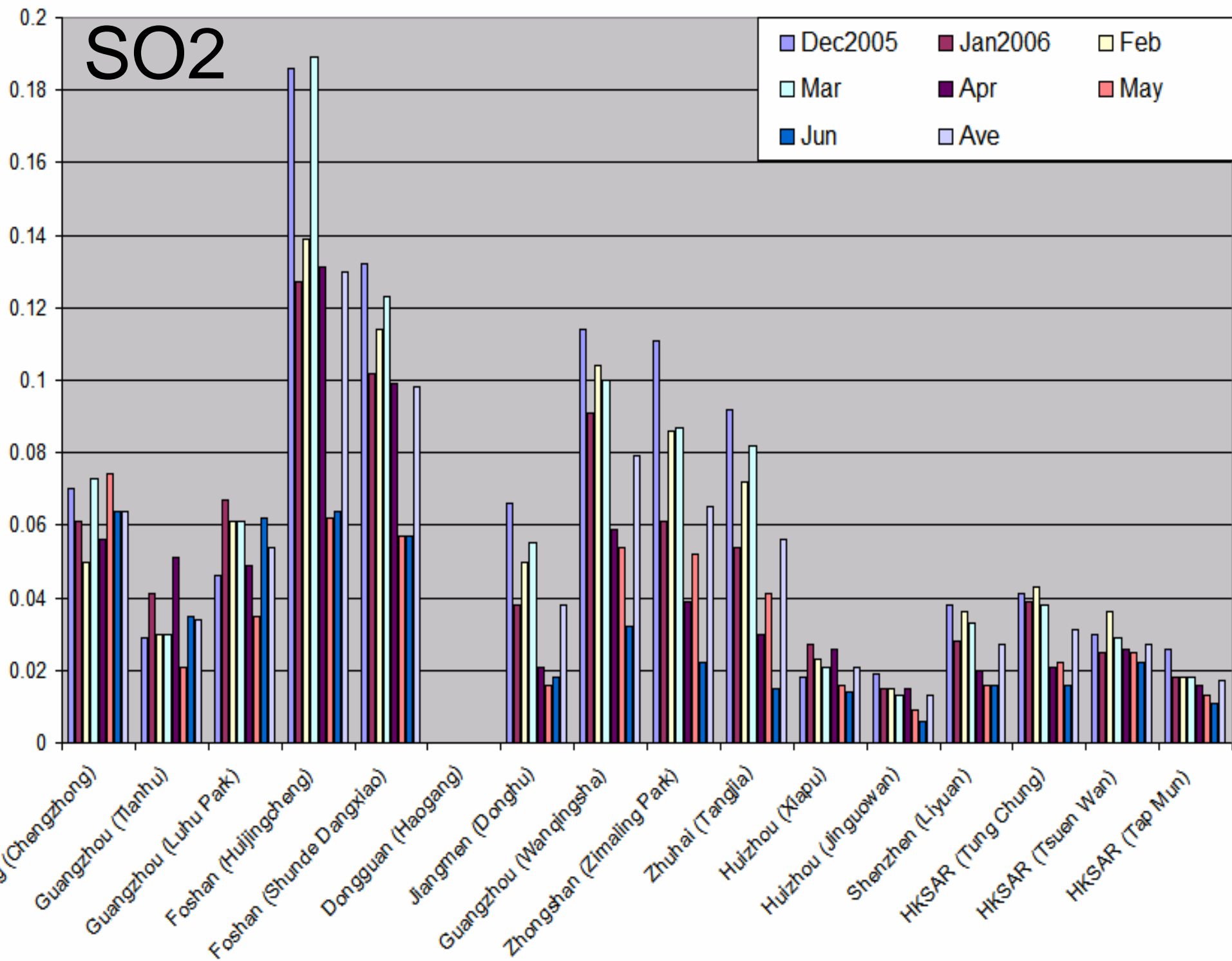
Tian Hu

Jing Guo Wan

Tap Mun

Hui Zhou

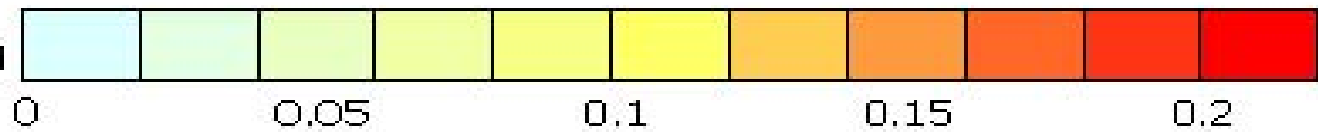
SO2



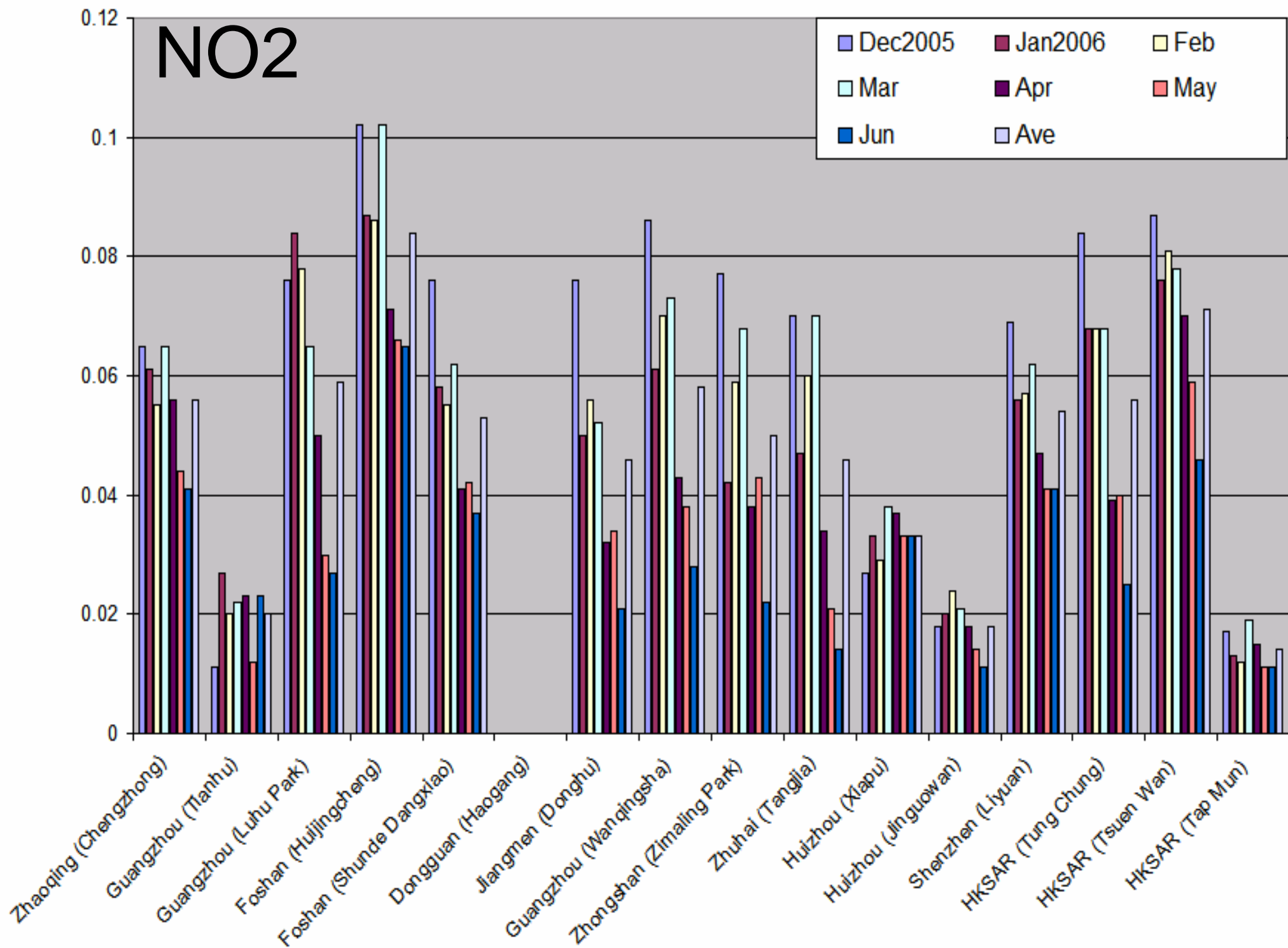
Distribution of average SO₂ from Dec 2005 to Jun 2006



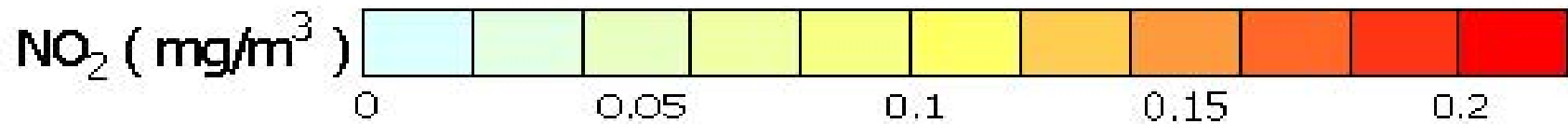
SO₂ (mg/m³)



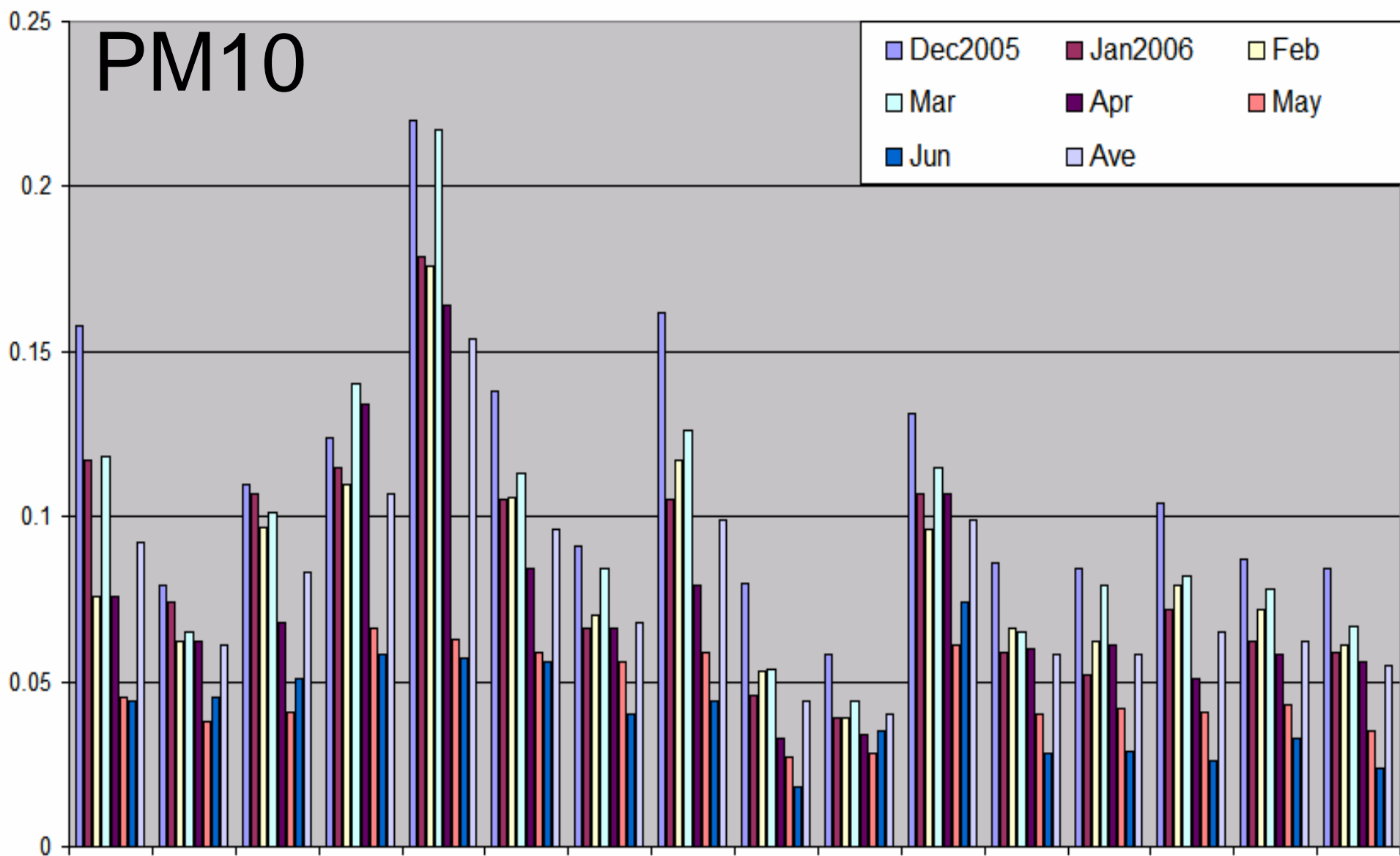
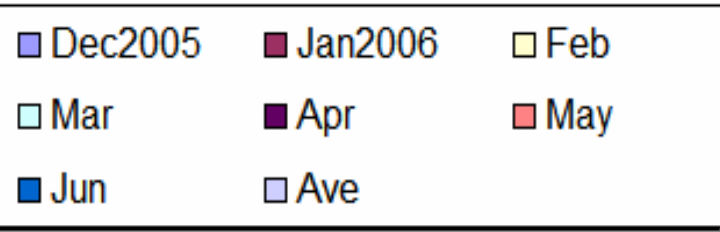
NO2



Distribution of average NO₂ from Dec 2005 to Jun 2006



PM10



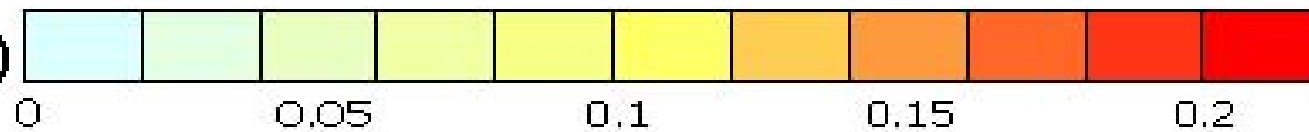
Locations (X-axis labels):

- Zhaoqing (Chengzhong)
- Guangzhou (Tianhu)
- Guangzhou (Luhu Park)
- Foshan (Huijingcheng)
- Foshan (Shunde Dangxiao)
- Dongguan (Haogang)
- Jiangmen (Donghu)
- Guangzhou (Wanqingsha)
- Zhongshan (Zimaling Park)
- Zhuhai (Tangjia)
- Huizhou (Xiapu)
- Huizhou (Jinguowan)
- Shenzhen (Liyuan)
- HKSAR (Tung Chung)
- HKSAR (Tsuen Wan)
- HKSAR (Tap Mun)

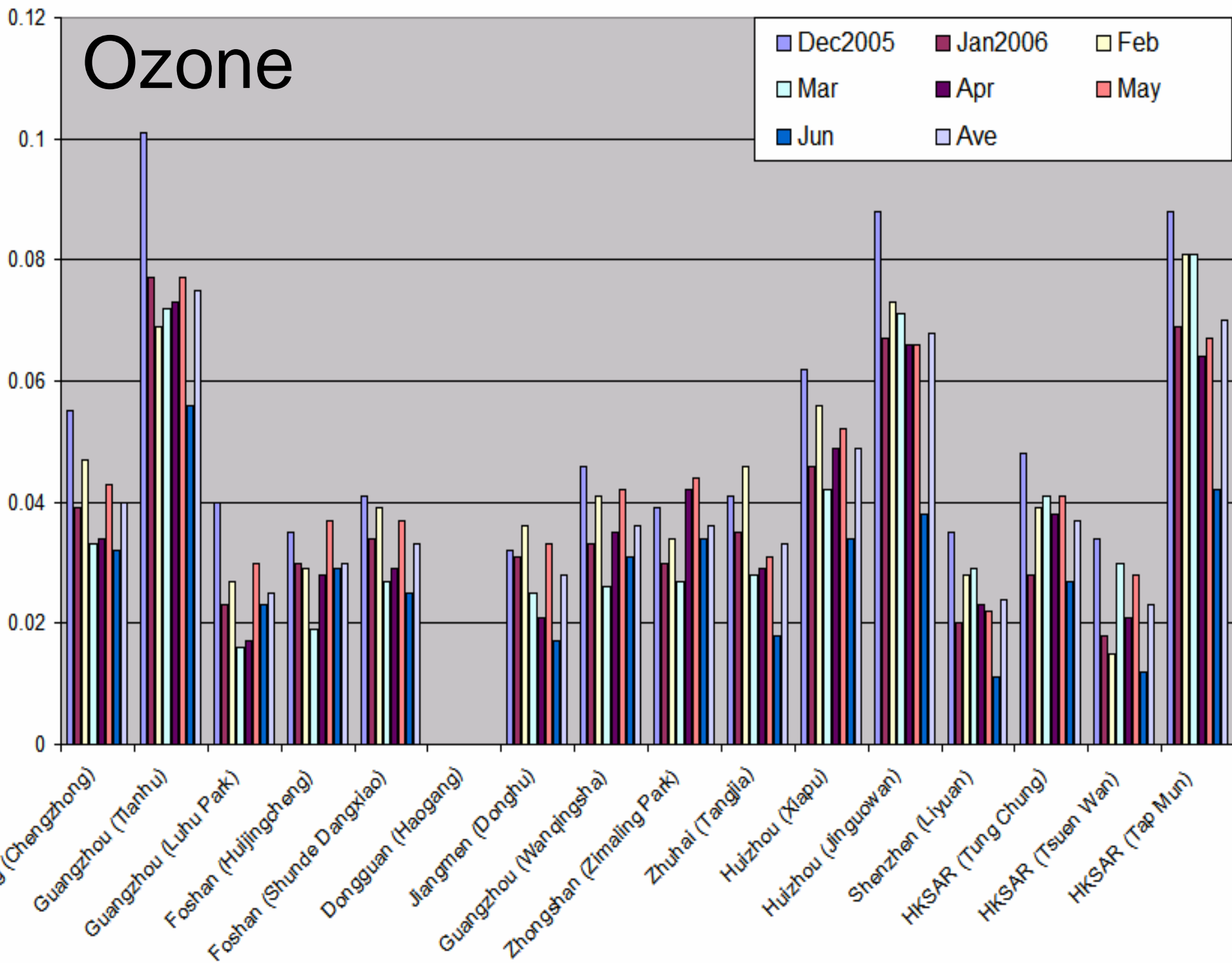
Distribution of average PM10 from Dec 2005 to Jun 2006



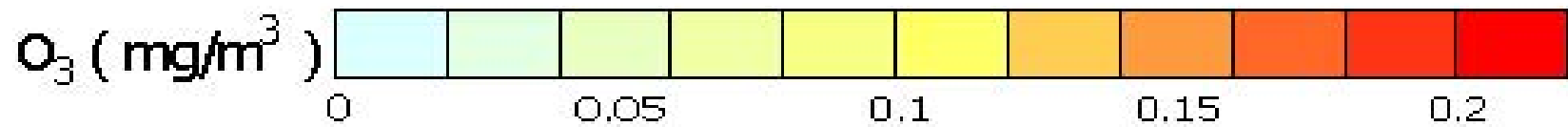
PM10 (mg/m^3)



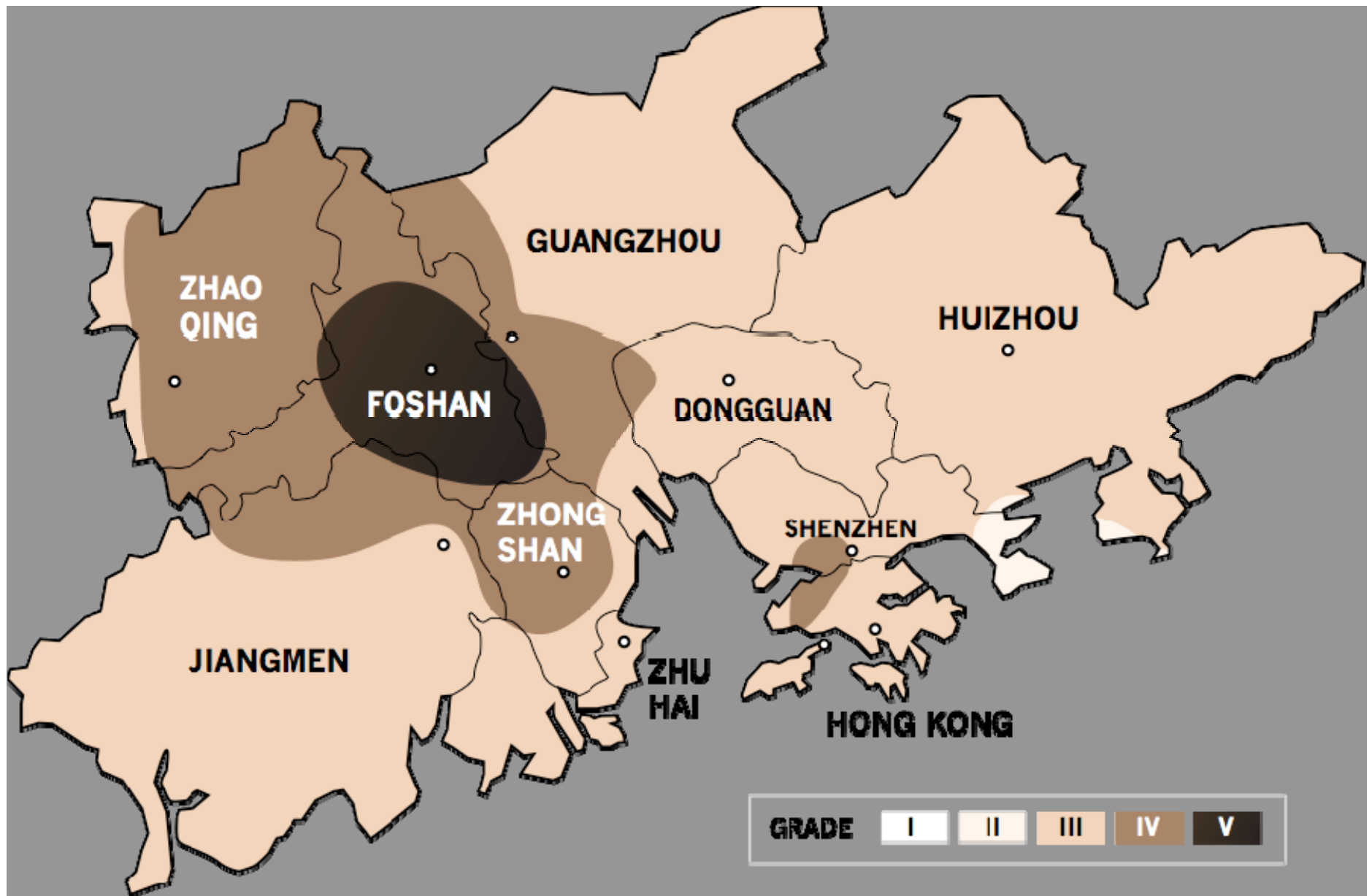
Ozone



Distribution of average O_3 from Dec 2005 to Jun 2006



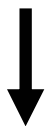
PRD Regional Air Quality – 1 February 2007



What a Difference ... good vs. bad days



Sunday 1 August 2004



Tuesday 4 January 2005



Sunday 18 July 2004



Wednesday 20 April 2005

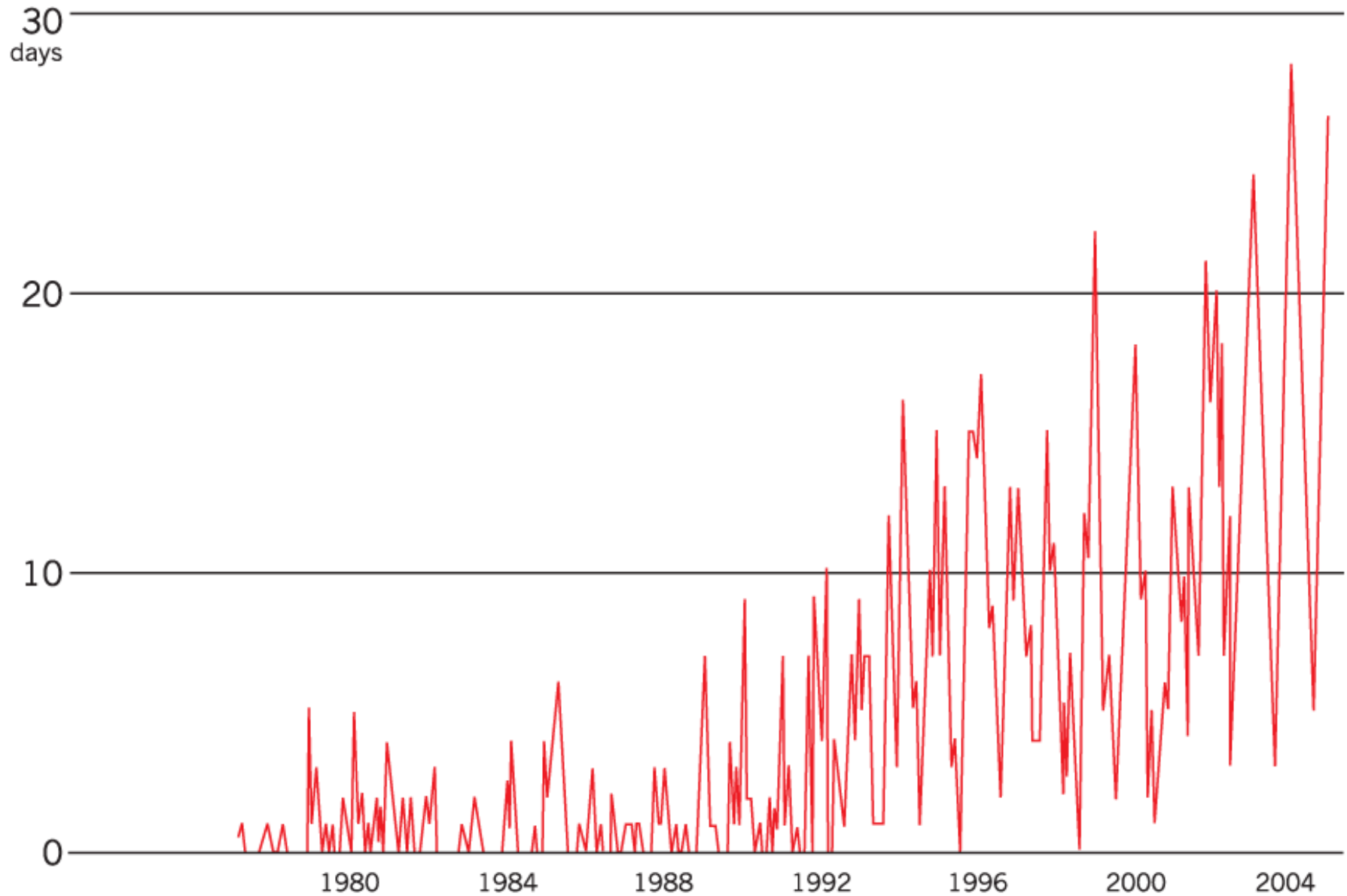


Friday 23 July 2004



Thursday 16 September 2004

Hazy Days per month (1977-2005)



Ranking of Container Ports of the World

Thousand TEUs

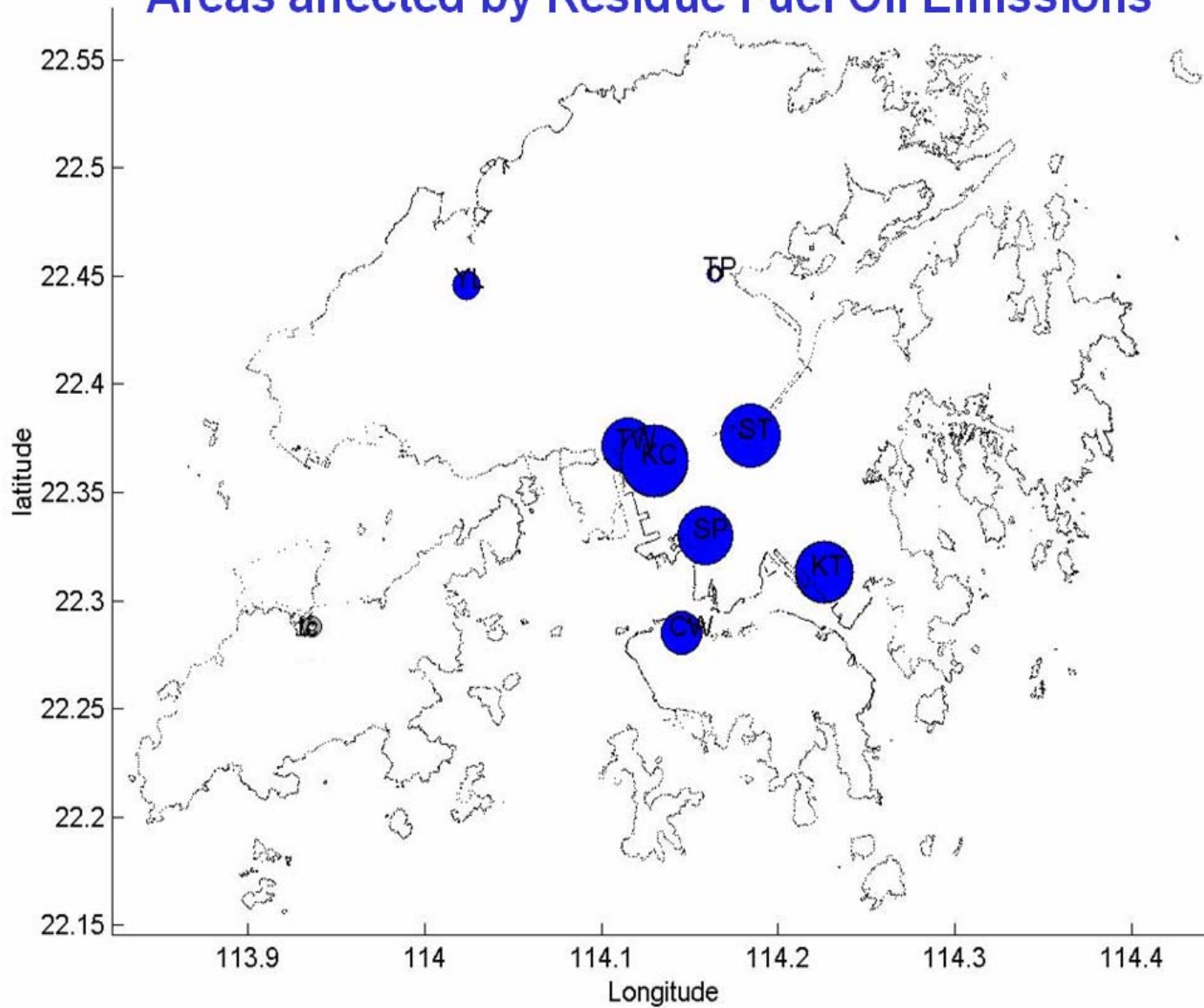
<u>Rank</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
1	Hong Kong 12 550	Hong Kong 13 460	Hong Kong 14 567	Singapore 15 100	Hong Kong 16 211	Hong Kong 18 098	Hong Kong 17 826	Hong Kong 19 144	Hong Kong 20 449
2	Singapore 11 846	Singapore 12 944	Singapore 14 140	Hong Kong 14 582	Singapore 15 945	Singapore 17 087	Singapore 15 571	Singapore 16 941	Singapore 18 411
3	Kaohsiung 4 900	Kaohsiung 5 063	Kaohsiung 5 693	Kaohsiung 6 271	Kaohsiung 6 985	Busan 7 540	Busan 8 073	Busan 9 453	Shanghai 11 280
4	Rotterdam 4 787	Rotterdam 5 007	Rotterdam 5 340	Rotterdam 6 011	Busan 6 440	Kaohsiung 7 426	Kaohsiung 7 541	Shanghai 8 610	Shenzhen 10 650
5	Busan 4 503	Busan 4 684	Busan 5 234	Busan 5 946	Rotterdam 6 400	Rotterdam 6 275	Shanghai 6 340	Kaohsiung 8 493	Busan 10 408
6	Hamburg 2 890	Hamburg 3 054	Long Beach 3 505	Long Beach 4 098	Long Beach 4 408	Shanghai 5 612	Rotterdam 6 096	Shenzhen 7 614	Kaohsiung 8 843
7	Long Beach 2 844	Long Beach 3 007	Hamburg 3 337	Hamburg 3 550	Shanghai 4 210	Los Angeles 4 879	Los Angeles 5 184	Rotterdam 6 506	Los Angeles 7 179
8	Yokohama 2 757	Los Angeles 2 683	Antwerp 2 969	Los Angeles 3 378	Los Angeles 3 829	Long Beach 4 601	Shenzhen 5 043	Los Angeles 6 106	Rotterdam 7 107
9	Los Angeles 2 555	Antwerp 2 620	Los Angeles 2 960	Antwerp 3 266	Hamburg 3 750	Hamburg 4 248	Hamburg 4 689	Hamburg 5 374	Hamburg 6 138
10	Antwerp 2 329	Yokohama 2 400	Dubai 2 600	Shanghai 3 066	Antwerp 3 614	Antwerp 4 082	Long Beach 4 463	Antwerp 4 777	Antwerp 5 445

Hong Kong and Shenzhen combined have the largest number of marine movements in a small space



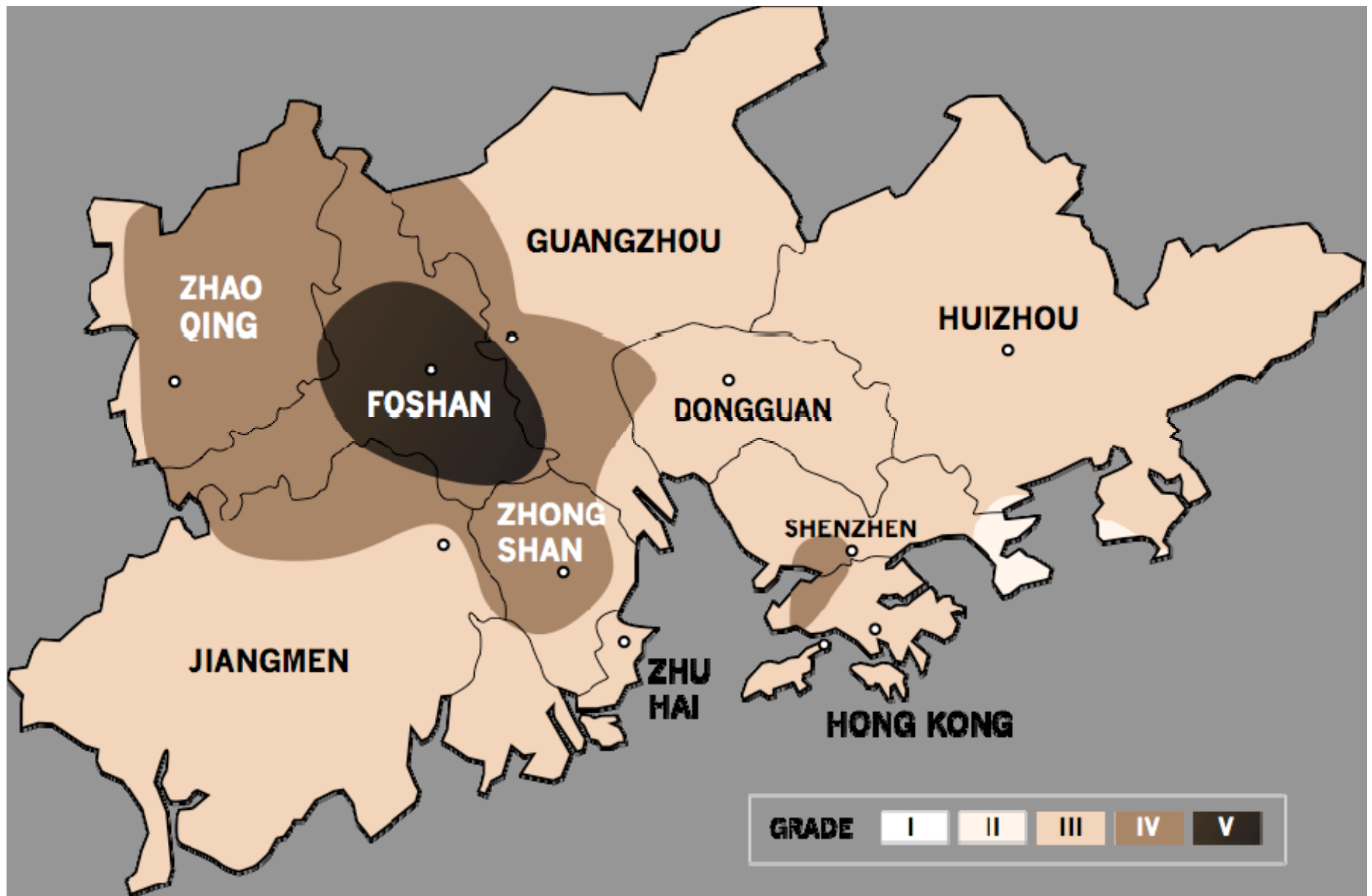


Areas affected by Residue Fuel Oil Emissions

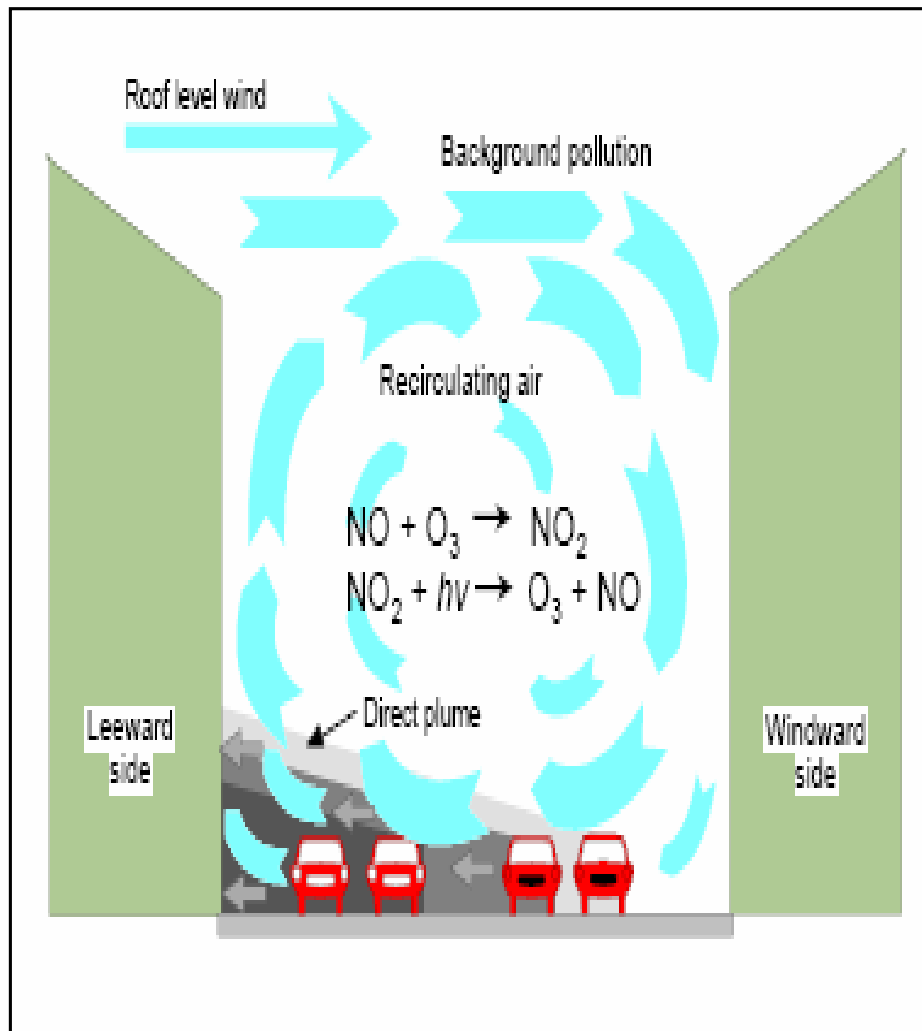


Areas affected by marine residual fuel oil emissions are the highly populated areas around and in WK, NWHK and Shatin

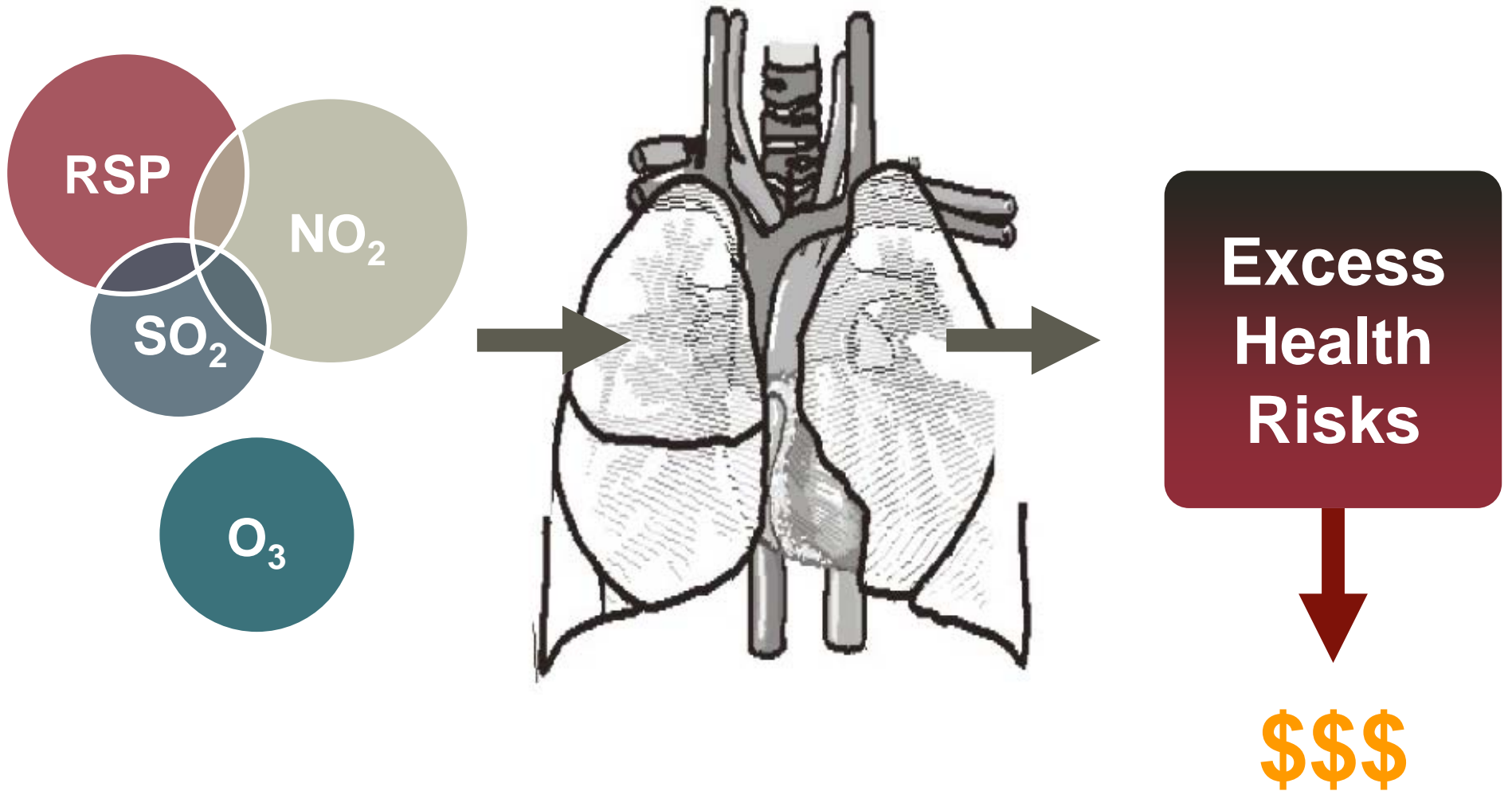
PRD Regional Air Quality – 1 February 2007



City Planning Impact

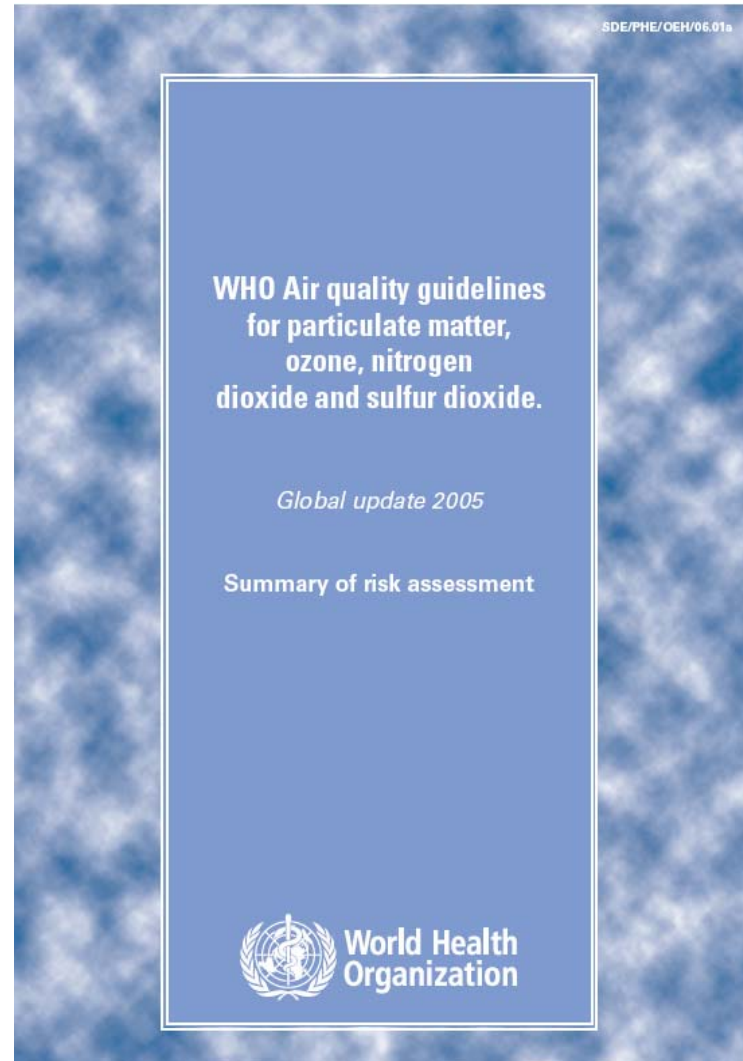


Air Pollution and Health Risks



WHO Air Quality Guidelines

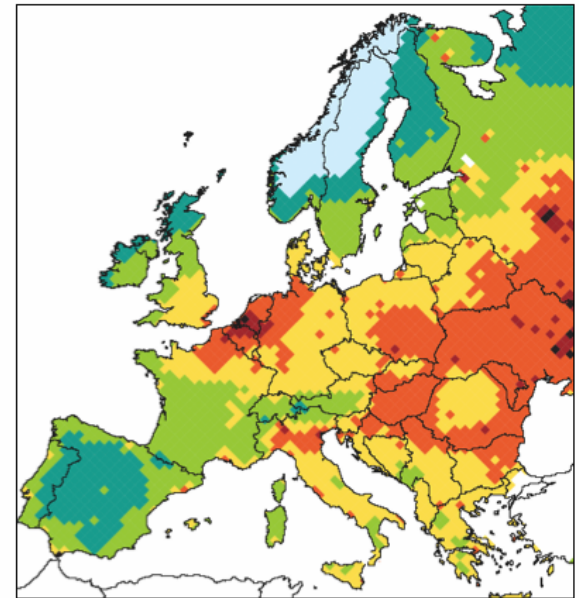
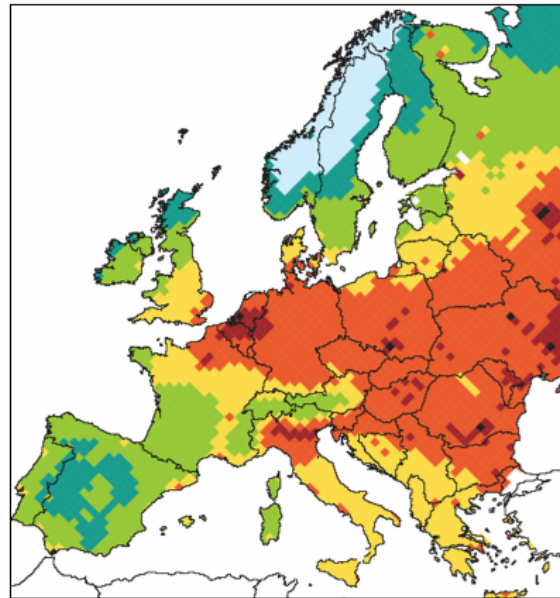
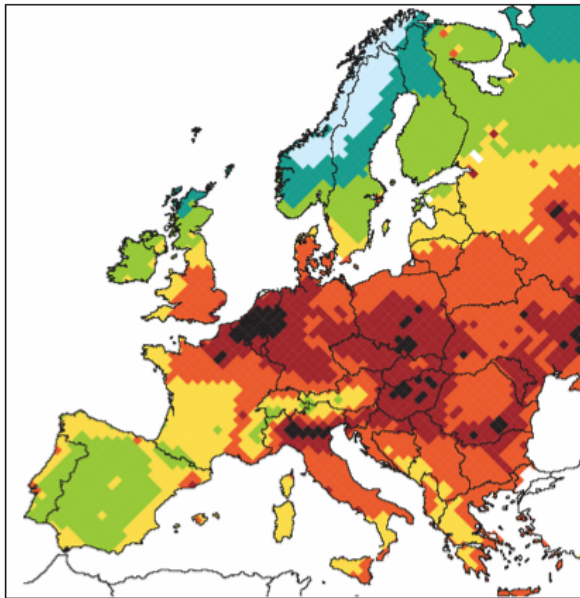
Released October 5th 2006



Shortening Life Expectancy in Europe

Standard $40 \mu\text{g}\cdot\text{m}^{-3}$

Standard $20 \mu\text{g}\cdot\text{m}^{-3}$



2000

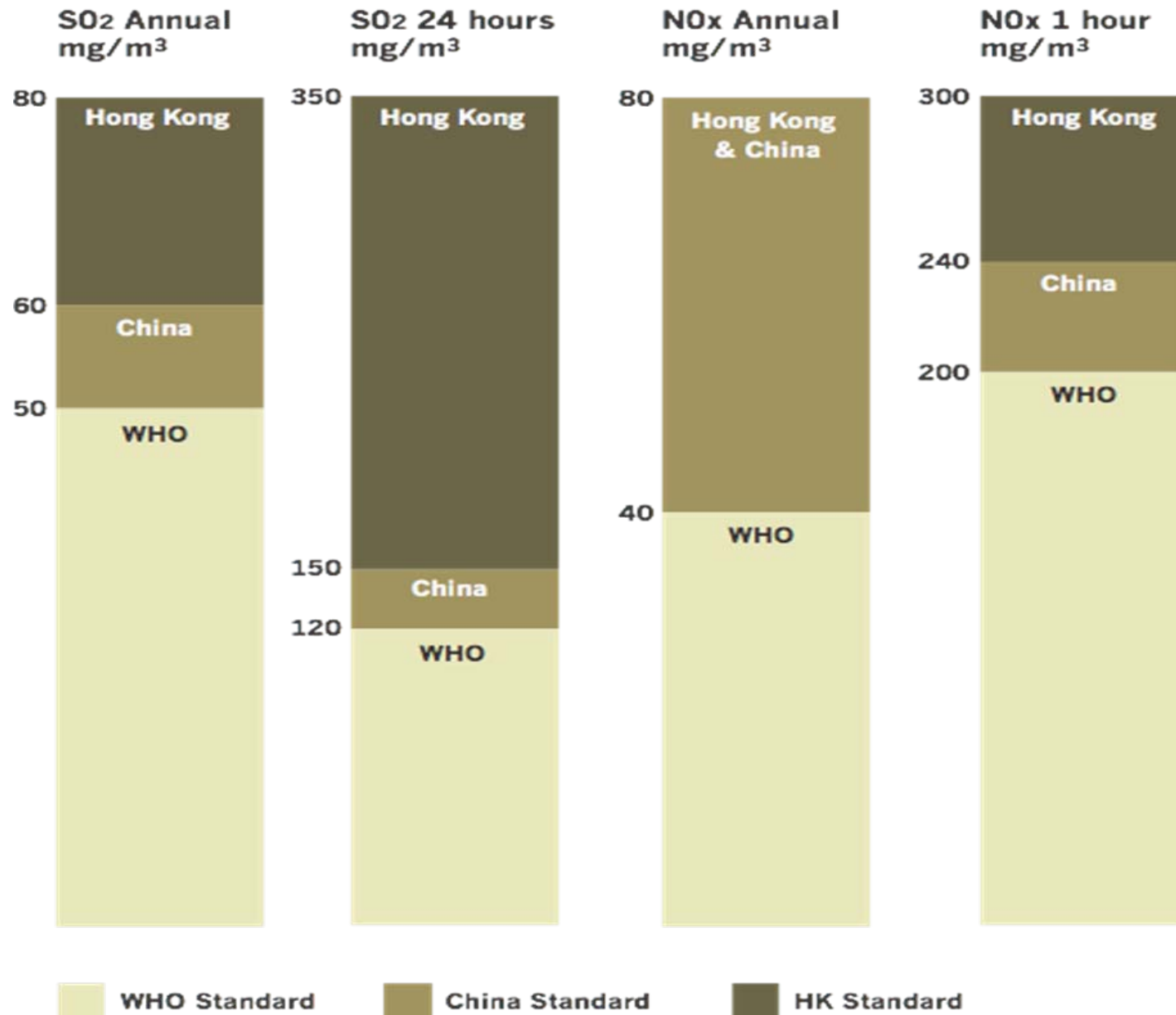
2010

2020

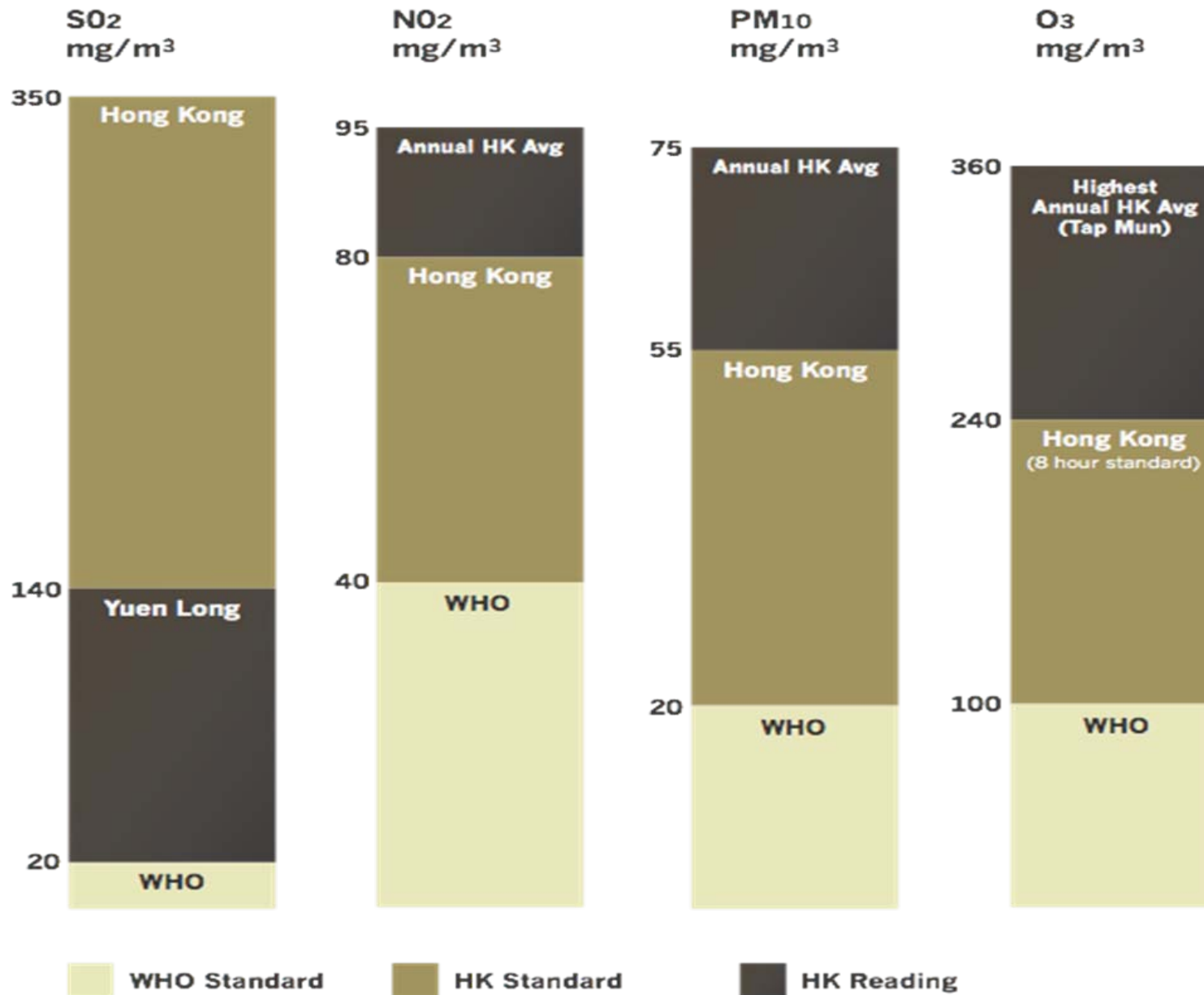
Shortening Life Expectancy in Months



Air Quality Standards Compared (WHO/China /HK)

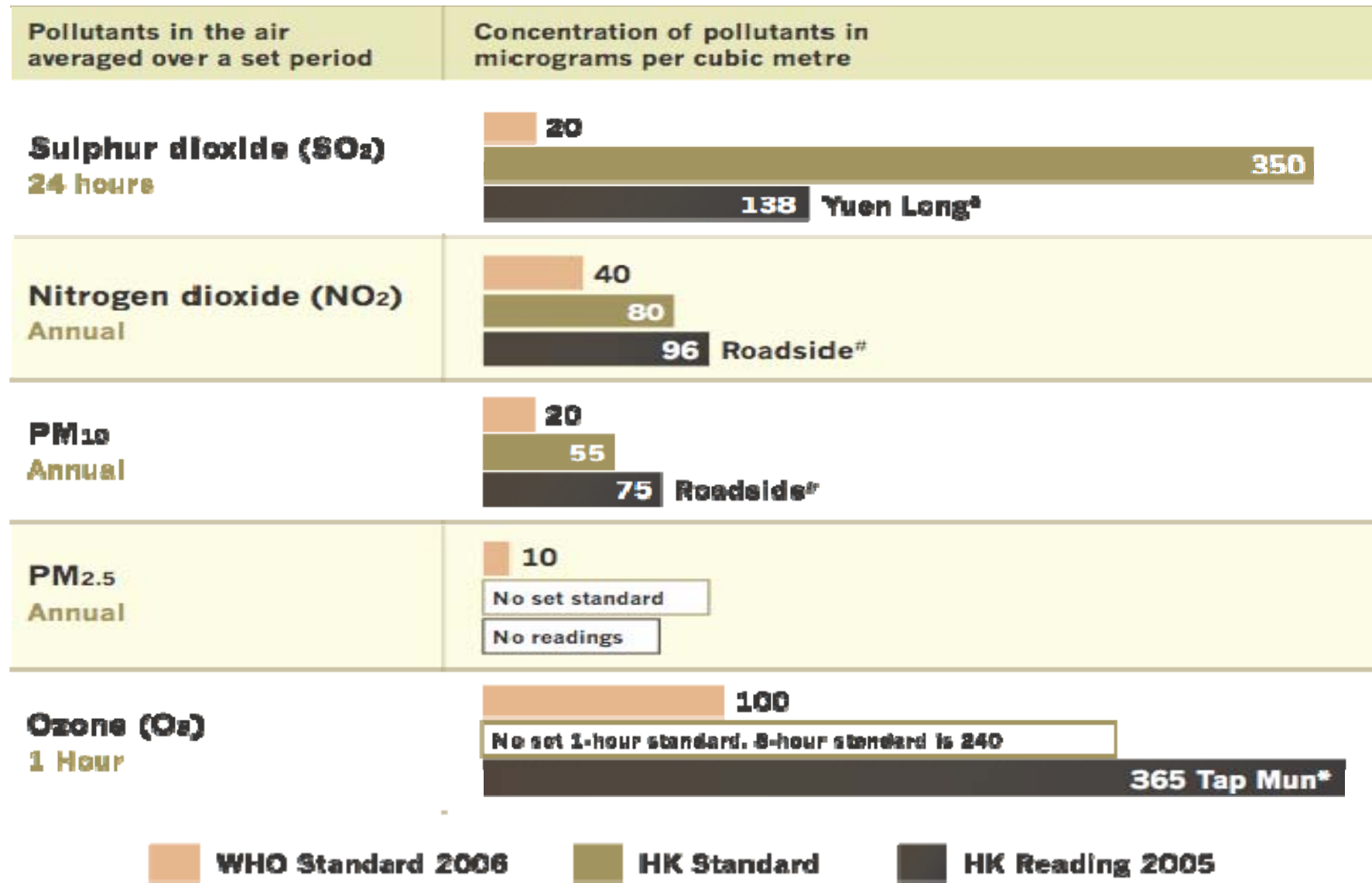


Air Quality Standards (WHO/HKAQO)



* HK has no set standard for PM_{2.5}

New Air Pollution Index needed



* Highest average figure # Annual average

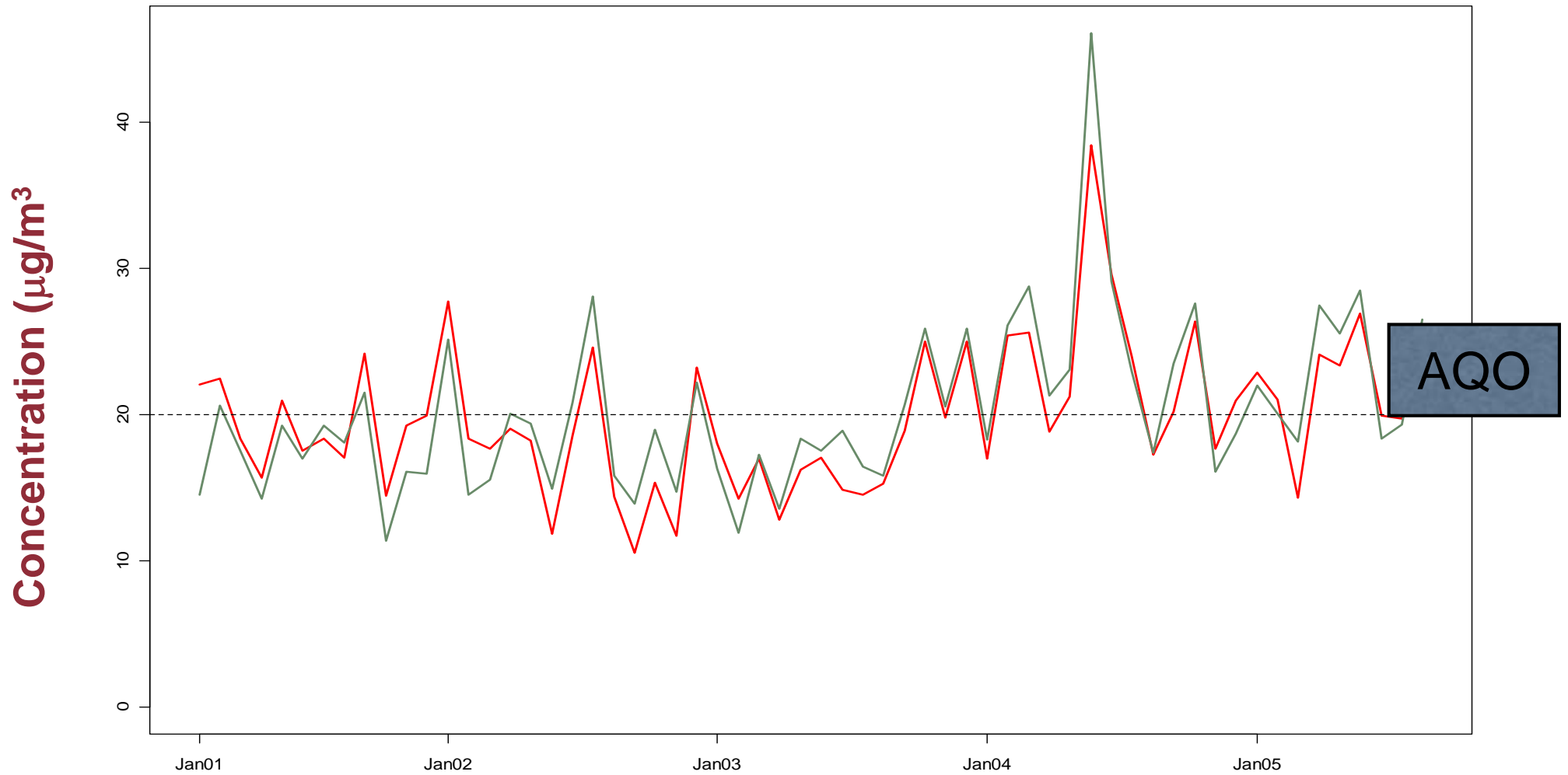
PM_x Suspended particulate matter of x micrometres or less in diameter

Hong Kong needs: New Air Pollution Index

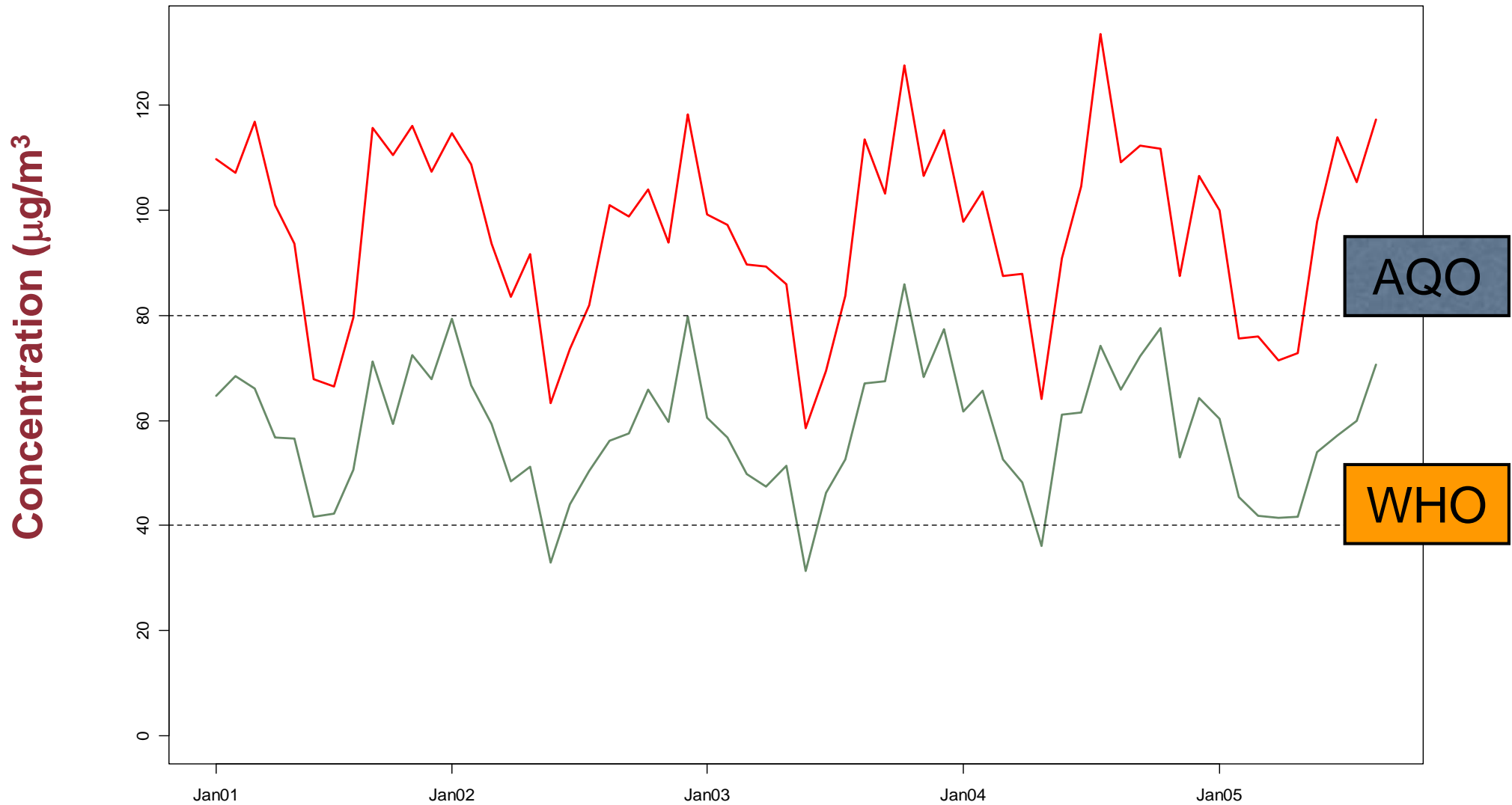
A low API of “25” is very unusual in Hong Kong – but is it a good indicator of health protection?

Difference in pollutants from WHO			
API 25	PM ₁₀	28 µg/m ³	(32% higher)
	SO ₂	40 µg/m ³	(100% higher)
Annual avoidable health impact of API 25			
	Excess Doctor Visits	Excess Hospital Admissions	Deaths
PM ₁₀	659,015	3,690	61
SO ₂	341,563	19,274	867
Total	959,590	20,651	824

SO₂ Monthly Concentration (2001-2005)

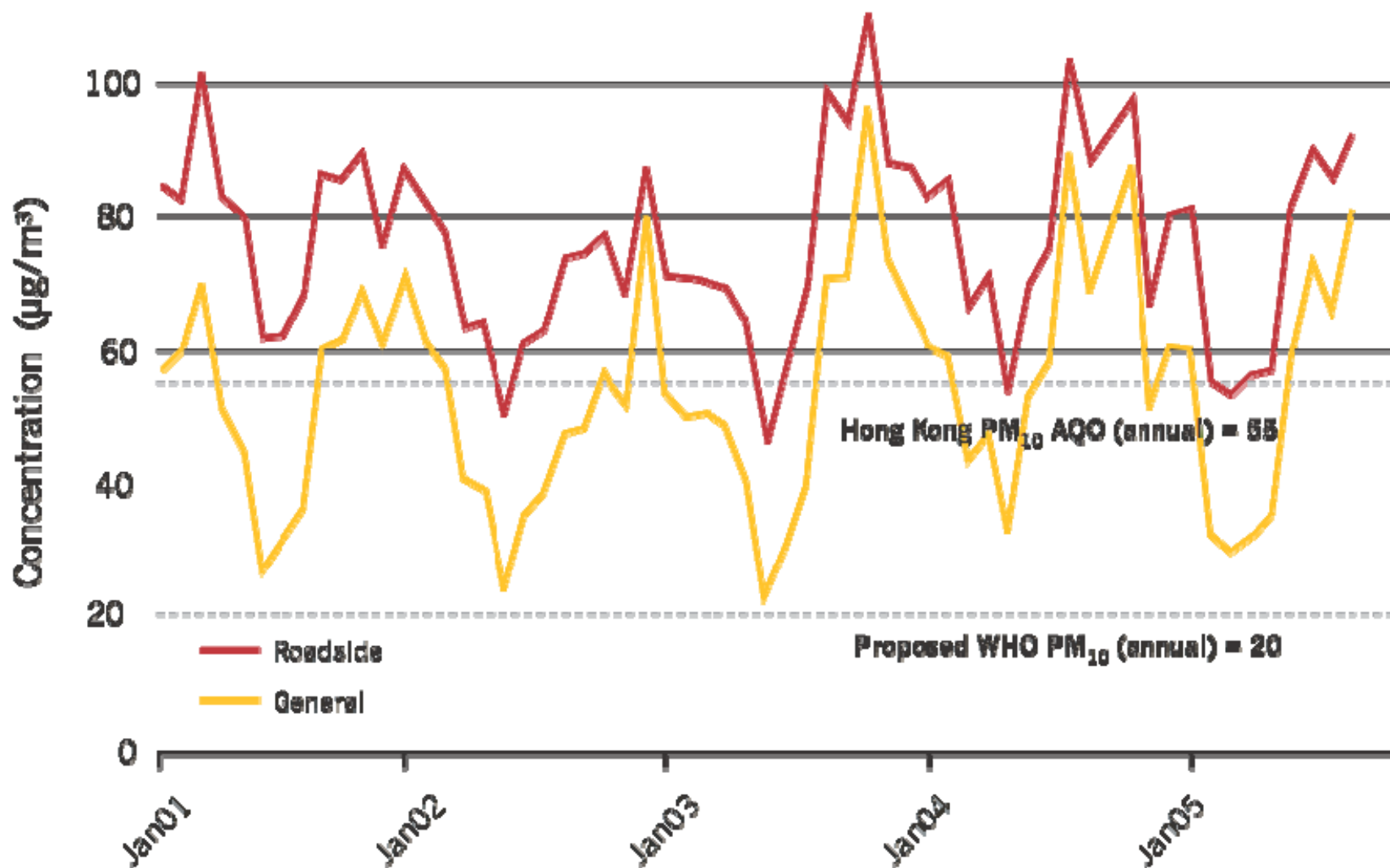


NO₂ Monthly Concentration (2001-2005)

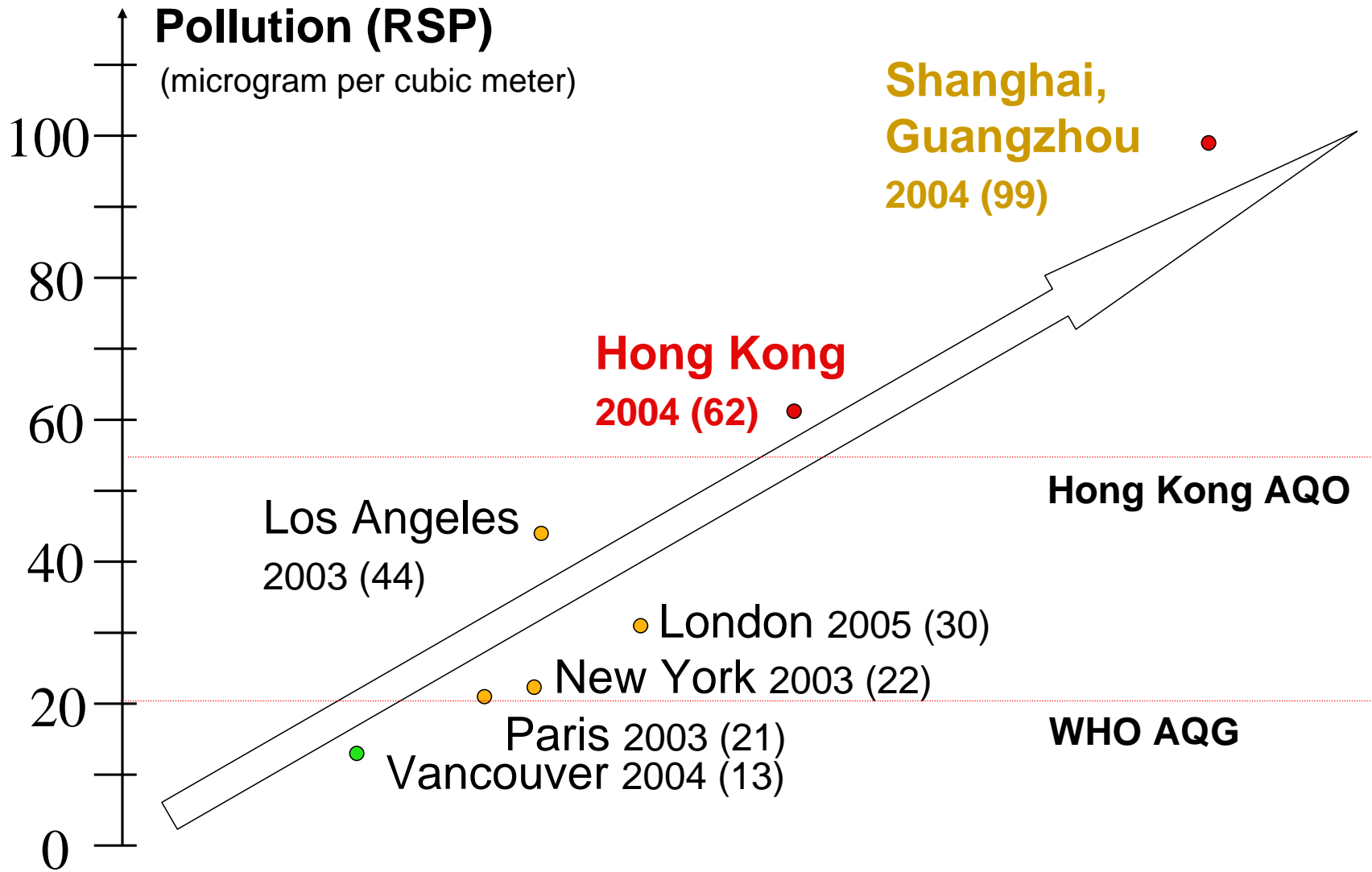


Monthly concentration of PM₁₀ (2001-2005)

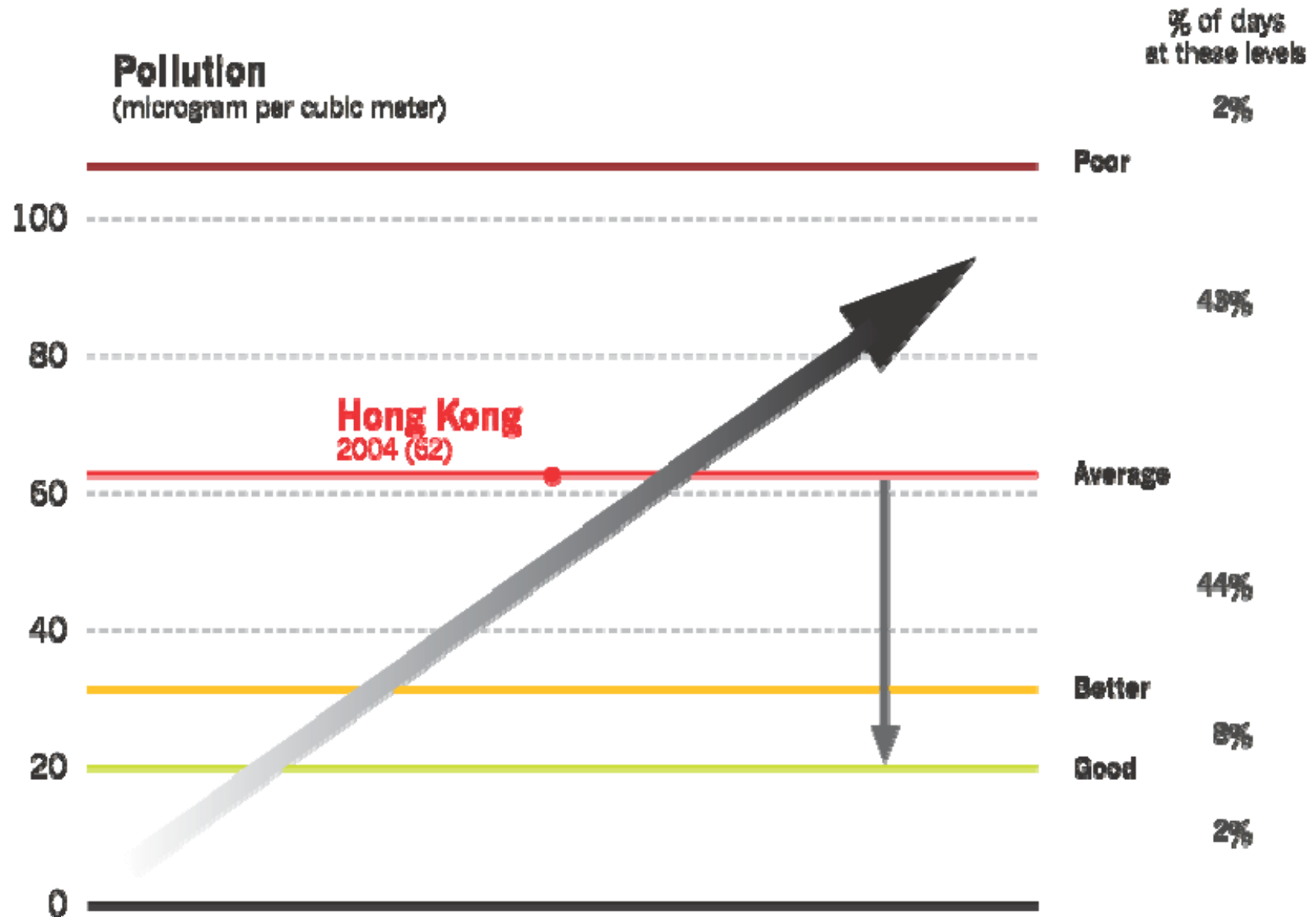
Where should we be for health protection?



AIR QUALITY ... better vs. worse



Avoidable Health Risks with Air Quality Improvement



Source: Department of Community Medicine, School of Public Health, University of Hong Kong

Value of the Avoidable Health Risks

Avoidable costs

Direct costs of illness

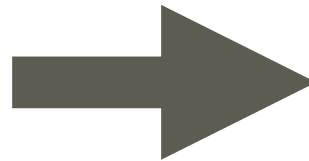
- Public hospital admissions
- Public out-patient consultations
- Private hospital admissions
- Family doctor visits
- Travel costs

Productivity losses

- Hospital admissions
- Family doctor visits
- Premature deaths

Intangible costs

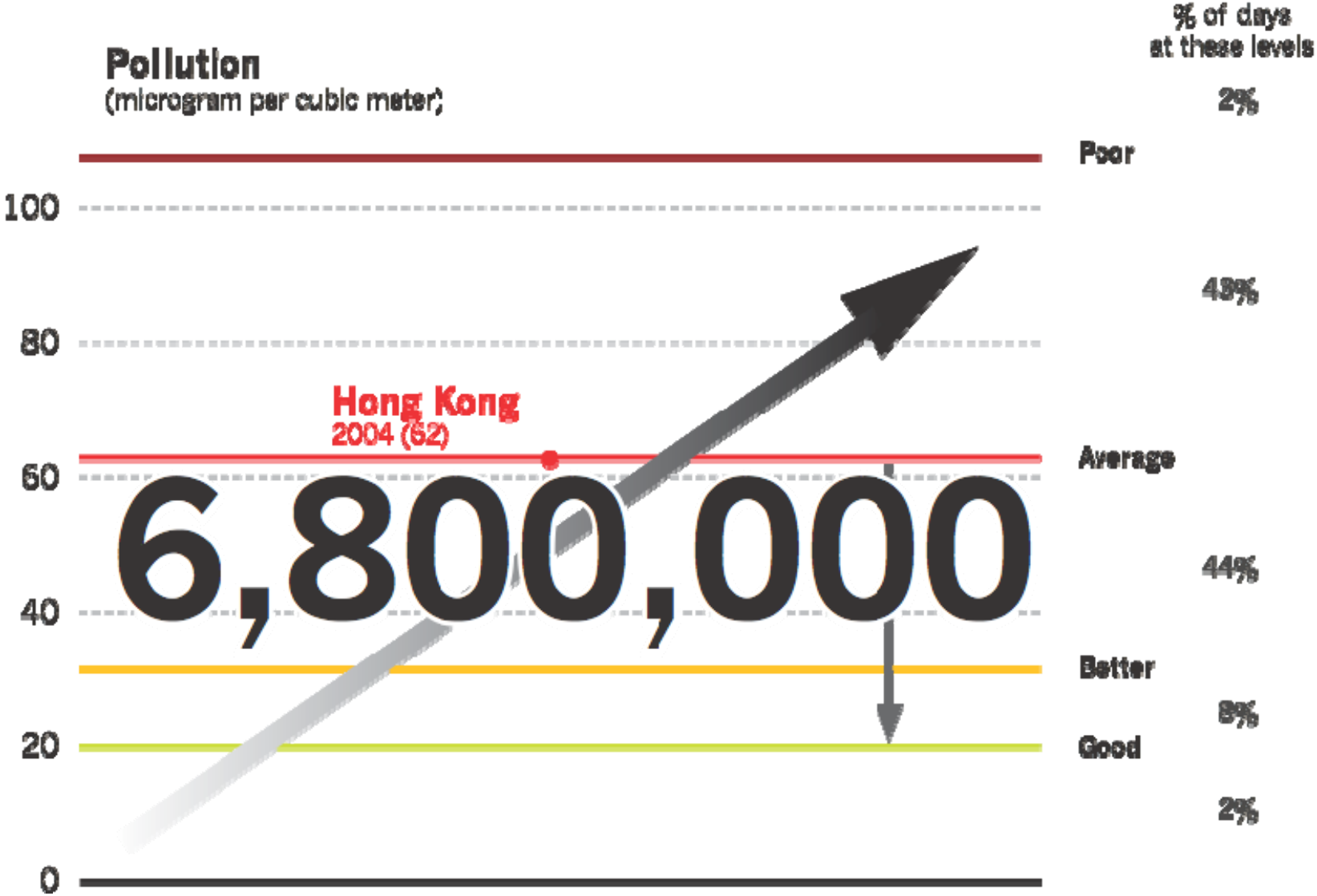
- Deaths
- Serious chronic illness
- Less serious illness



**\$ VALUE OF
HARM AVOIDED**

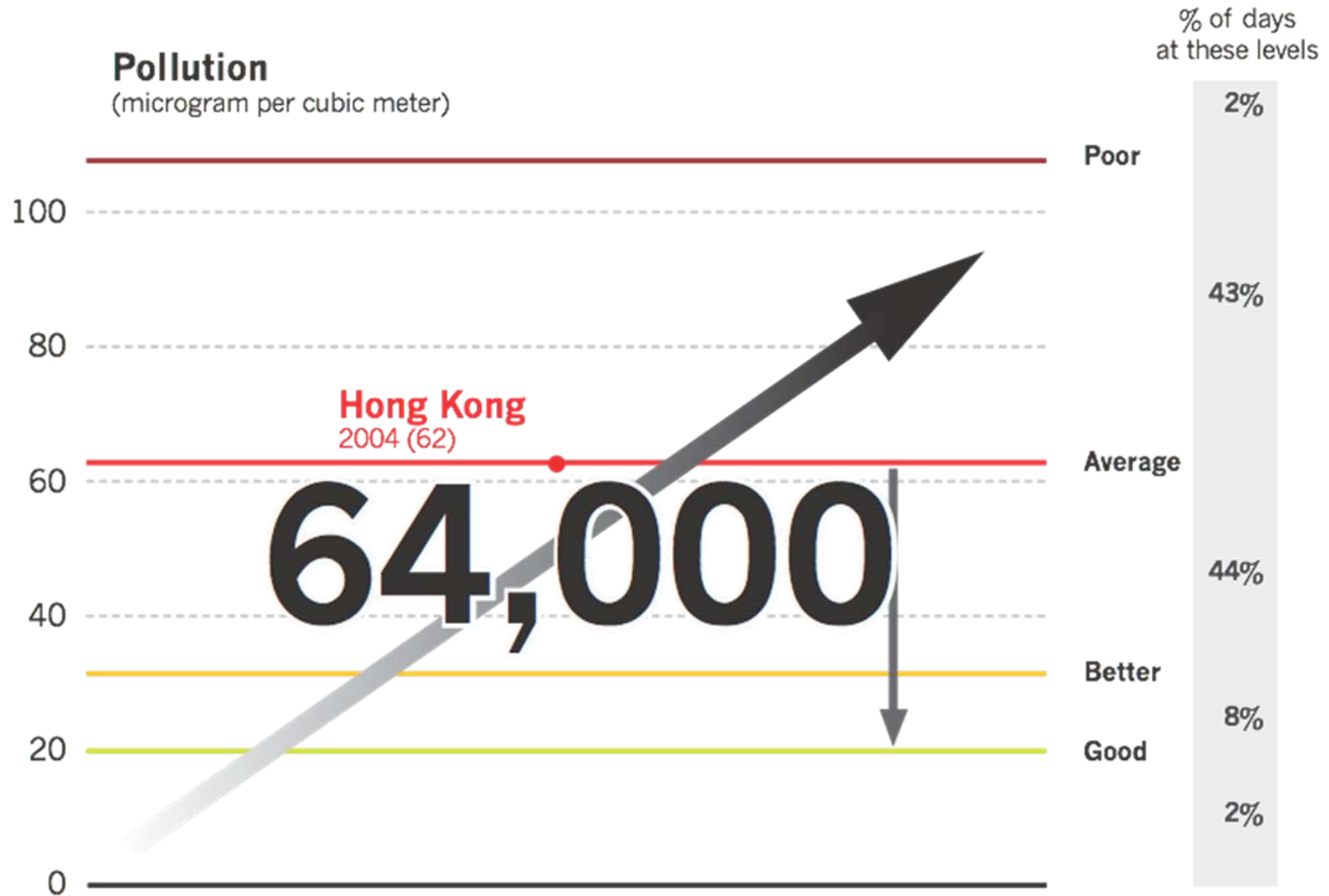


Family Doctor visits for Respiratory Problems

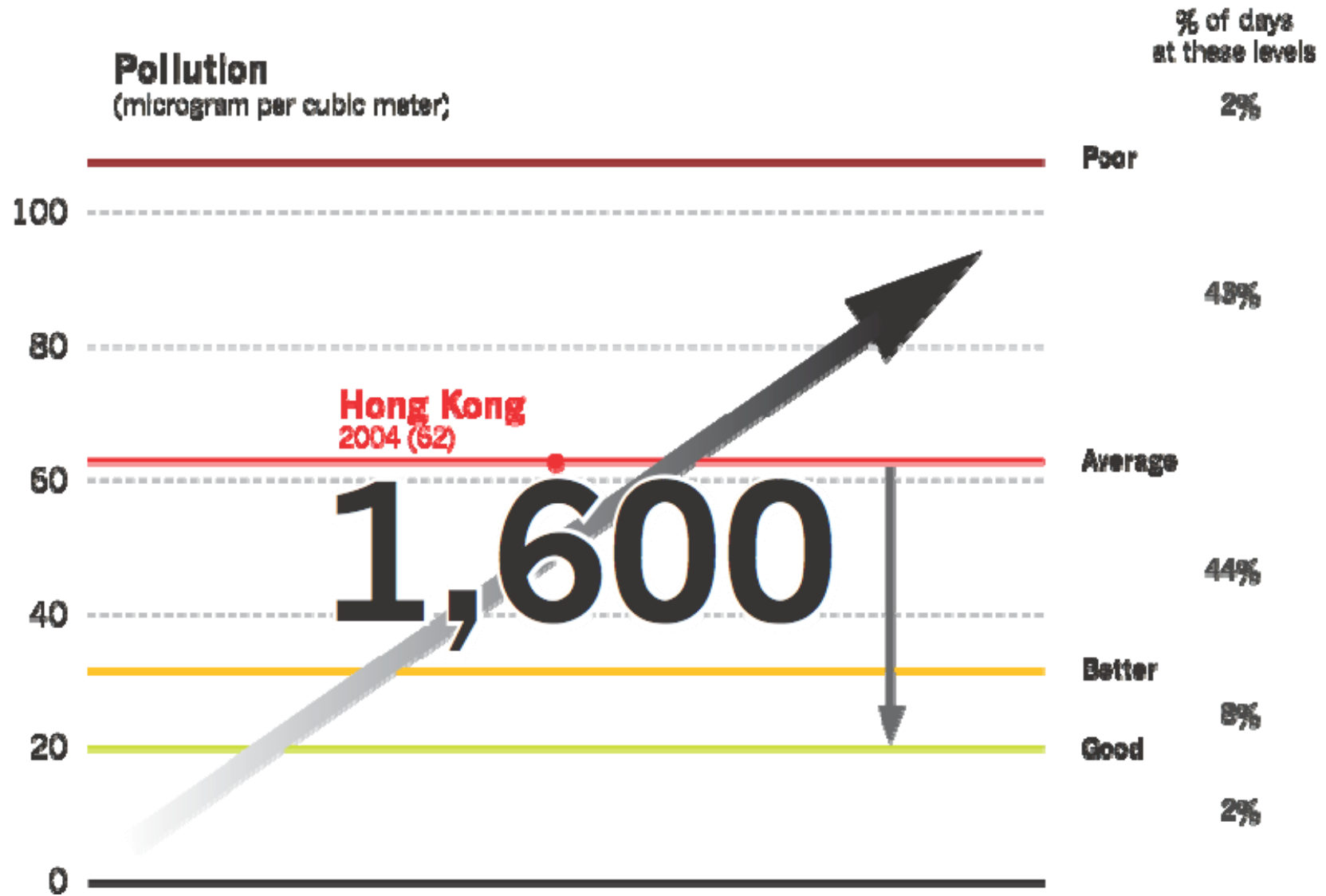


Source: Department of Community Medicine, School of Public Health, University of Hong Kong

Hospital Beds-days Avoided



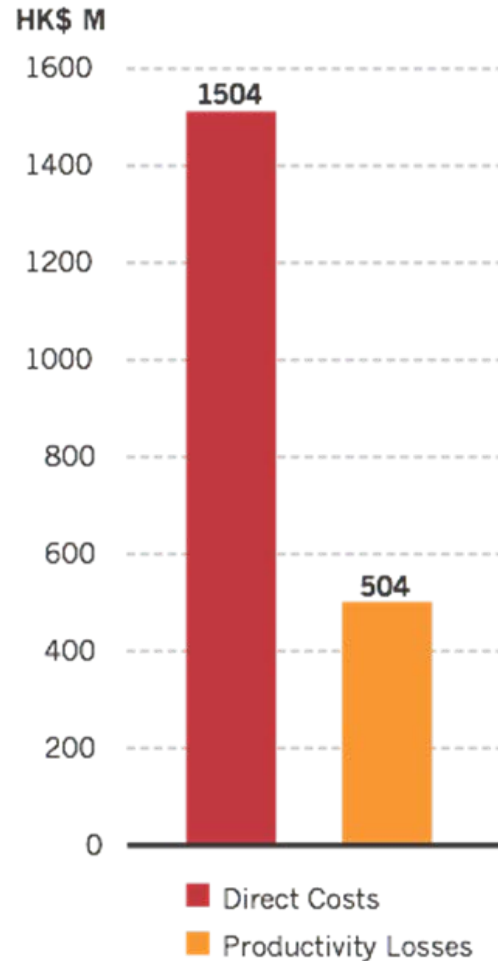
Deaths Avoided



\$ Benefits of Air Quality Improvement

Direct Health Costs & Productivity Loss Avoided

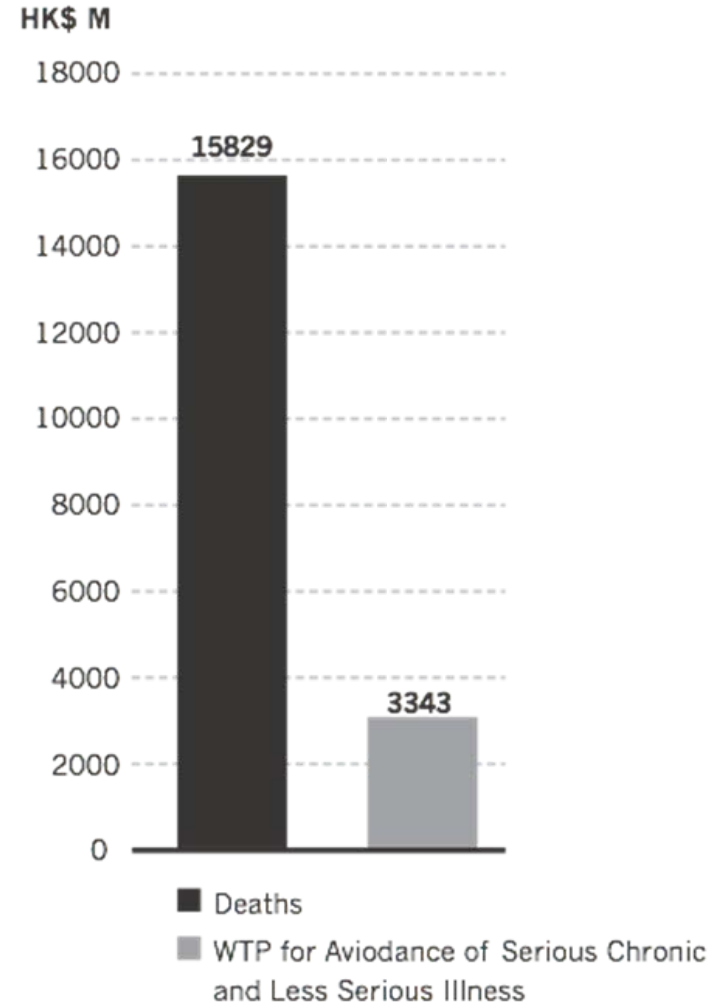
Total: HK\$20,08M



+
Total value of harm avoided
\$21,180M

Intangible Costs for Pain & Suffering

Total: HK\$19,172M



Health Costs of Air Pollution

The Five Most Avoidable Numbers in Hong Kong

200 Air pollutant concentrations are now 200% higher than the World Health Organization Guidelines 2006.

6,800,000 Family doctor visits each year for respiratory problems.

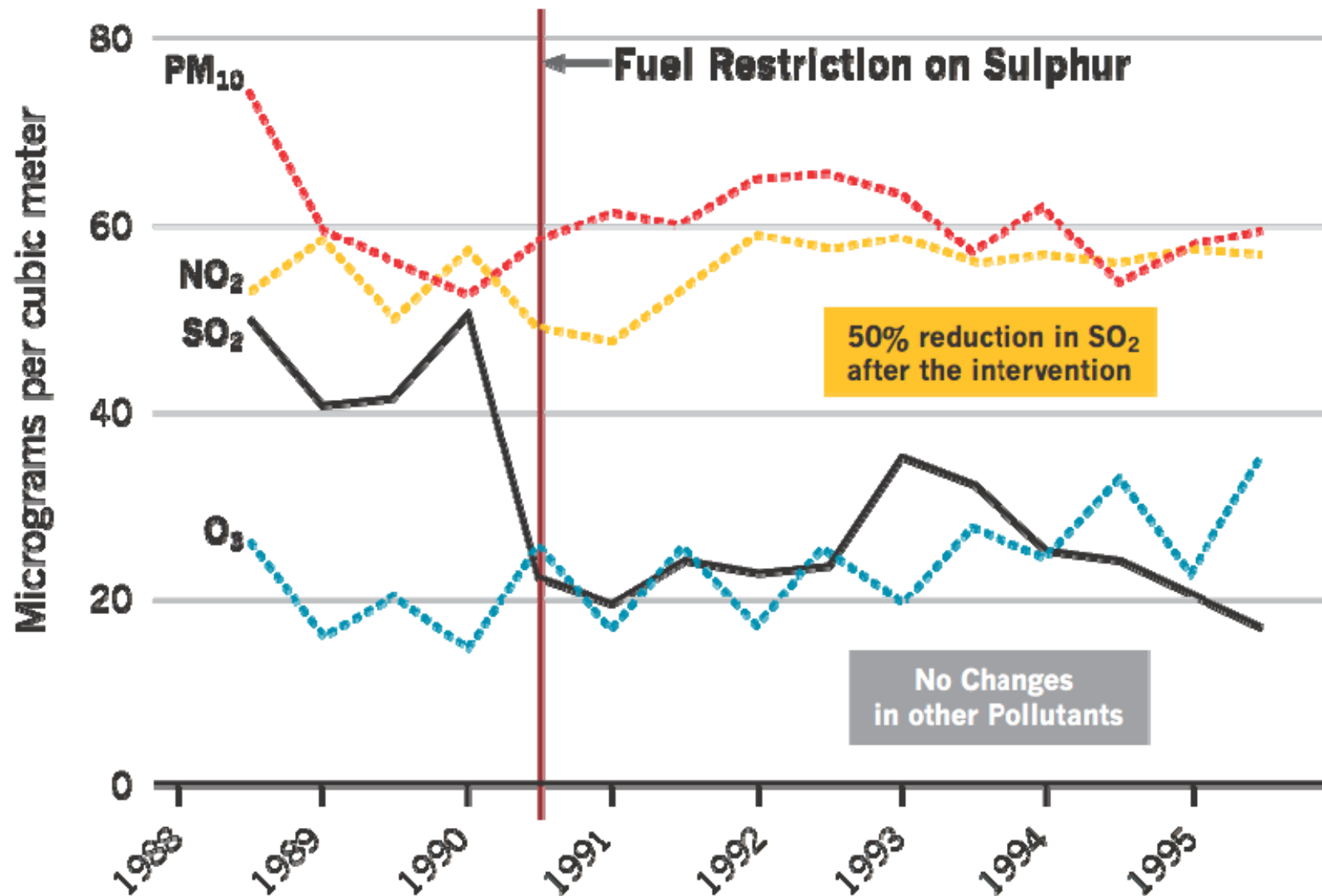
64,000 Hospital bed-days a year, mostly for heart, lung and blood vessel diseases.

1,600 Deaths a year, mostly from heart attacks, stroke, pneumonia and other lung diseases.

20 Value of the benefits of air quality improvement would be more than HK\$20 billion a year.

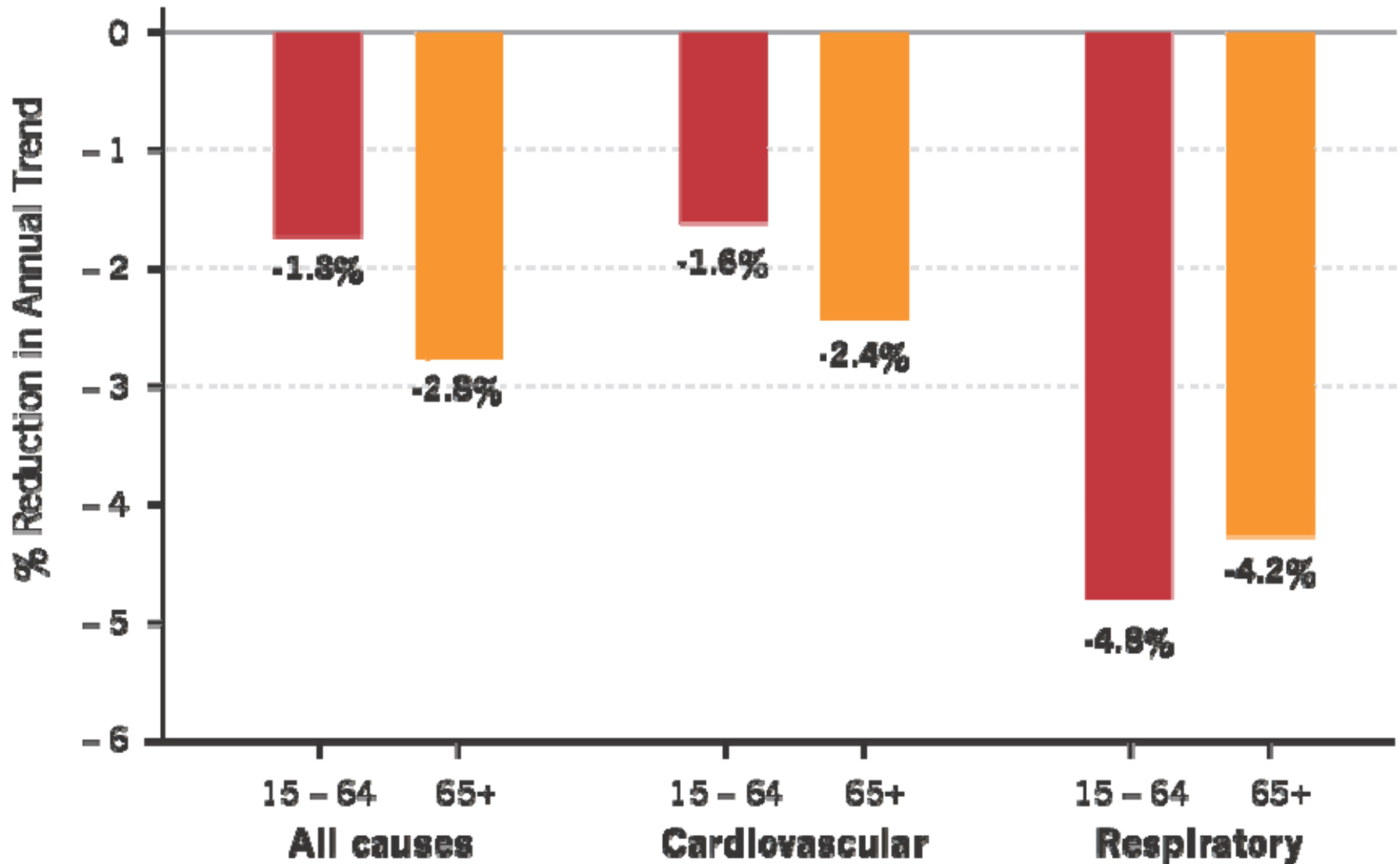
Air Pollutant Concentrations (1988-1995)

Half yearly mean level



Reduction in Heart & Lung Disease Deaths

After 1990 Sulphur Restriction



Some key issues ...

- Hong Kong air quality is poor and is a threat to health.
- Air Quality Objectives (AQOs) should be set at levels that protect public health.
- Current guidelines are inadequate and misleading.
- WHO Air Quality Guidelines (2006) are based on the best scientific information available today and should be adopted in Hong Kong.

View from the Top

Donald Tsang said in May 2006 ...

“In fact the air is not all that bad ... [it] is not inferior to Washington DC ... By Asian standards ... we are better than Seoul, any of the Mainland cities ... better than Taipei ... slightly behind Singapore [and] behind Tokyo ... I am sure we are going to meet whatever [WHO] standards they put up”.

Donald Tsang said in November 2006

“We have the most environmentally friendly place for people, for executives, for Hong Kong people, to live”.

Economy is being affected

Merrill Lynch warns 2006 ...

“Skilled professionals are departing Hong Kong because of this. More will follow ... Singapore stands to be a major beneficiary and the investment response is clear. Buy (shares in) Singapore office landlords, sell Hong Kong office landlords.”

ECA Adapt Rankings 2005/06

SINGAPORE: No. 1 in Asia

HONG KONG: 32

SHANGHAI: 89

BEIJING: 106

(down 12 places since 04/05)

(down 2 places since 04/05)

(down 5 places since 04/05)

HONG KONG-PRD NEED A COMPREHENSIVE PLAN

**Power Generation and
Demand Management**

**Transport and
Urban Planning**

**Shipping and
Port Operations**

**Manufacturing and
Cleaner Fuels**

**Market Mechanisms
Tax and Emissions Trading**

Civic Exchange Comprehensive AQM Plan 2006

Air Management Plan Timeline

	2006	2007	2008	2009	2010	2011	2012
Sharpen Policy Tools		<p>New Energy Policy : Energy efficiency through public procurement (2007 onwards); Revise Schemes of Control (2007-2008); Appoint new ministerial post (2007); Promote District Level Energy Efficiency Campaign (2007 onwards)</p> <p>Air Quality : Tighten AQOs (2007) Recalibrate API (2007) Start Air Pollution Alerts (2007)</p>					
A Comprehensive Approach (Local Air Pollution)	<p>Power Generation : Impose Lamma Power Station emissions cap (2006); Announce fuel mix policy (2006-2007); Secure LNG supply (2007); Explore emissions trading</p>						
	<p>Vehicular Transport : Devise strategy for cleaner vehicles and fuels (2007); Practice better planning and urban design (2007-2008); Legislate to stop idling engines (2007-2008); Tax and license according to emissions (2007); Promote biodiesel and ethanol (2007); Discounts to cross-border vehicles that refuel at border (2008); Start electronic road pricing (2008-2009); Impose emission caps on bus companies (2008-2009); Replace Pre-Euro and Euro I buses (2010); Pre-Euro and Euro I vehicles off the road (2010); Create Low Emissions Zone (2010); Only Euro III or better vehicles on the road (2012)</p>						
	<p>Expedite Railway/Subway Expansion : South Island Line, North Island Line, Shatin-Central Line; the Northern Link (2007 onwards)</p>						
	<p>Shipping and Port Operations : Reduce vessel speed in harbour (2006); Use lower sulphur fuels (2007) Promote latest technologies in emission abatement (2007 onwards); Shore-side power for ships at dock (2007) Tariff concessions, financial support and other incentives (2007-2008); Ratify Annex VI MARPOL Convention (2006-2007) so HK may be declared a Sulphur Emissions Control Area in the future</p>						
	<p>Airport operations : Ask Airport Authority to explore how airport operations can reduce emissions and be more energy efficient.</p>						
A Comprehensive Approach (Regional Air Pollution)	<p>Manufacturing : Promote use of cleaner fuels for private generators in Shenzhen and Dongguan.</p>						
	<p>Ports, Shipping and Logistics : Devise Regional Green Port Policy (2008-2009) Request Central People's Government ratify Annex VI of MARPOL so PRD waters may be declared a Sulphur Emissions Control Area (2009-2010)</p>						
	<p>Air Quality Management : Provide real time air quality data (2007); Fund joint HK-Macau-PRD air quality research and collaboration, Create Regional Air Resources Board (2012)</p>						
Pro-actively Facilitate Industries to Reduce Emissions	<p>Facilitate Industry Sectors to become Energy Efficient and Reduce Emissions (2007-2008) : Power generation; Transport; Manufacturing Port and Airport operation and logistics; Design and construction</p>						
National and International Efforts	<p>Participate in National and International Efforts (2006 onwards) : Safeguard national treasures (e.g. Magao Grottoes, Dunhuang) Join International Council for Local Environmental Initiatives (ICLEI) Join Large Cities Climate Leadership Group</p>						

Hong Kong Policy Priorities

Create policy drivers to effect change:

- Review and tighten air quality guidelines
- Adopt integrated energy policy



Other measures from sharpening policy drivers:

- Install FGD equipment in all power plants
- Push energy efficiency
- Replace old vehicles quickly
- Require adding biodiesel at border for trucks
- Prioritise rail and coordinate bus service and other road usage
- Manage density to reduce “street canyon effect”
- Operate clean ports and logistics

Regional Policy Priorities

TRANSPORT

Use cleaner fuels, newer buses and extend rail

MANUFACTURING

Use cleaner fuels, energy efficiency

POWER

Close smaller plants, improve efficiency and reduce emissions

PORTS

Use cleaner fuels on ships, vehicles and equipment

INFORMATION

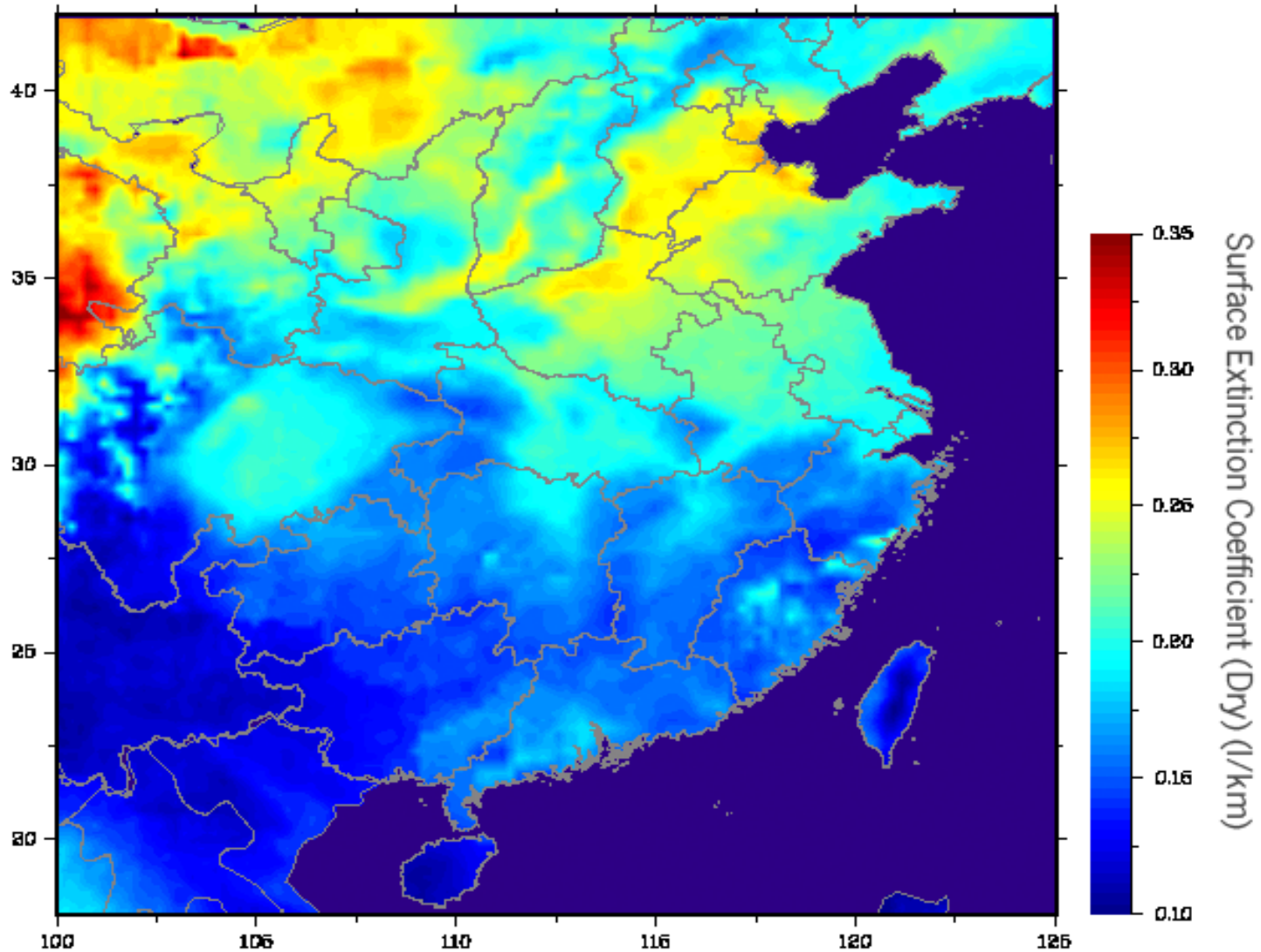
Sustain joint air monitoring and release full emissions data

COOPERATION

Build cross-border planning & regulatory framework, increase capacity in air management, pilot emissions trading

Super Regional Trends Particulates Pollution in China (2000)

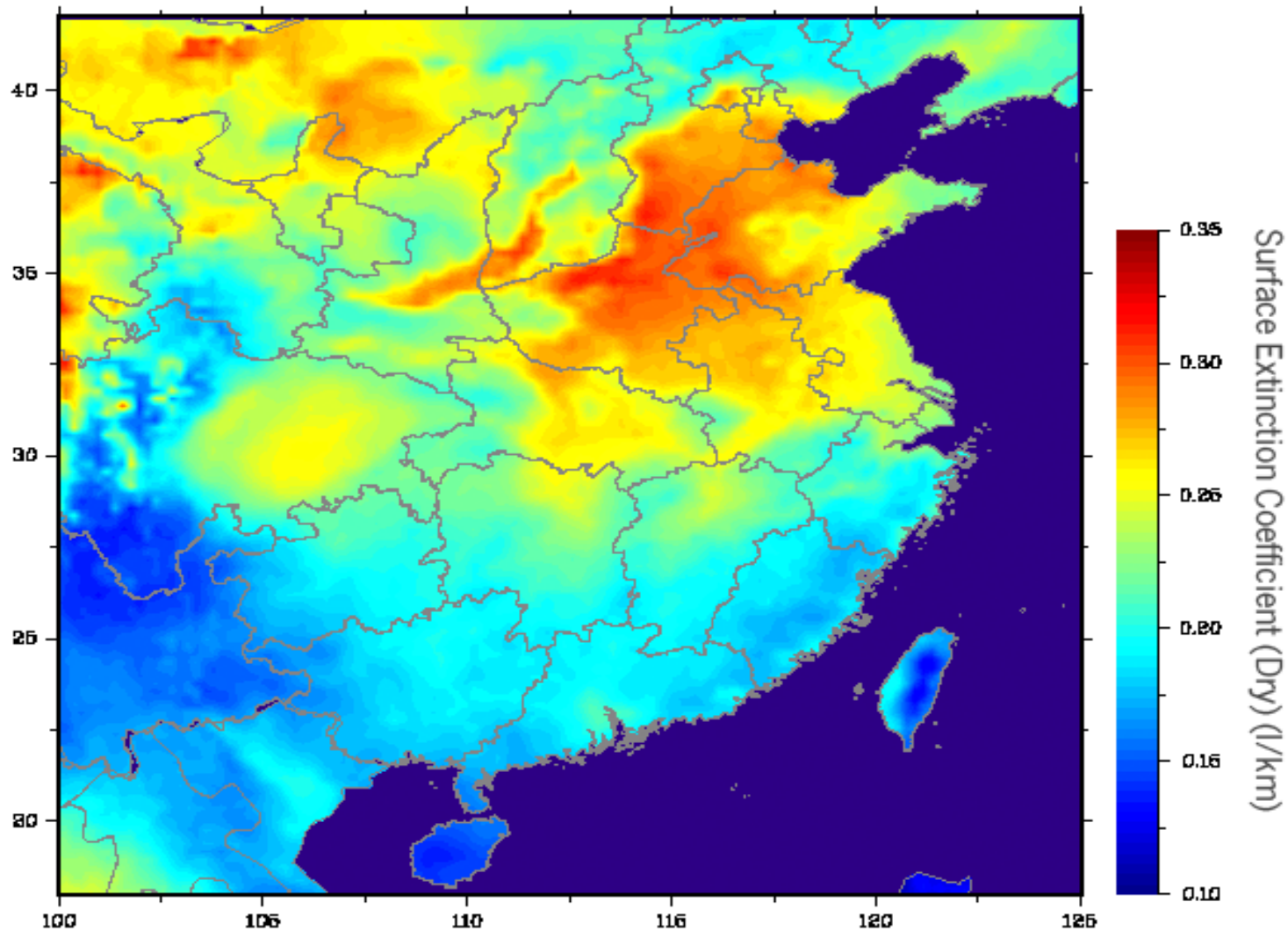
SEC (Dry) Yearly AVG 2000 (min: 0.09 max 0.32)



Courtesy: HKUST, Institute for the Environment

Super Regional Trends Particulates Pollution in China (2005)

SEC (Dry) Yearly AVG 2005 (min: 0.09 max 0.32)



Courtesy: HKUST, Institute for the Environment

A hazy, golden-hour photograph of a city skyline, likely Hong Kong, with a prominent skyscraper and a large crane in the foreground. The scene is bathed in a warm, yellowish light, suggesting either sunrise or sunset. The sky is filled with soft, diffused light and some light clouds. The city buildings are silhouetted against the bright sky, with the most prominent one being a tall, slender skyscraper. In the foreground, the dark silhouette of a large crane or construction structure is visible on the right side, and the water of a harbor or bay is at the bottom.

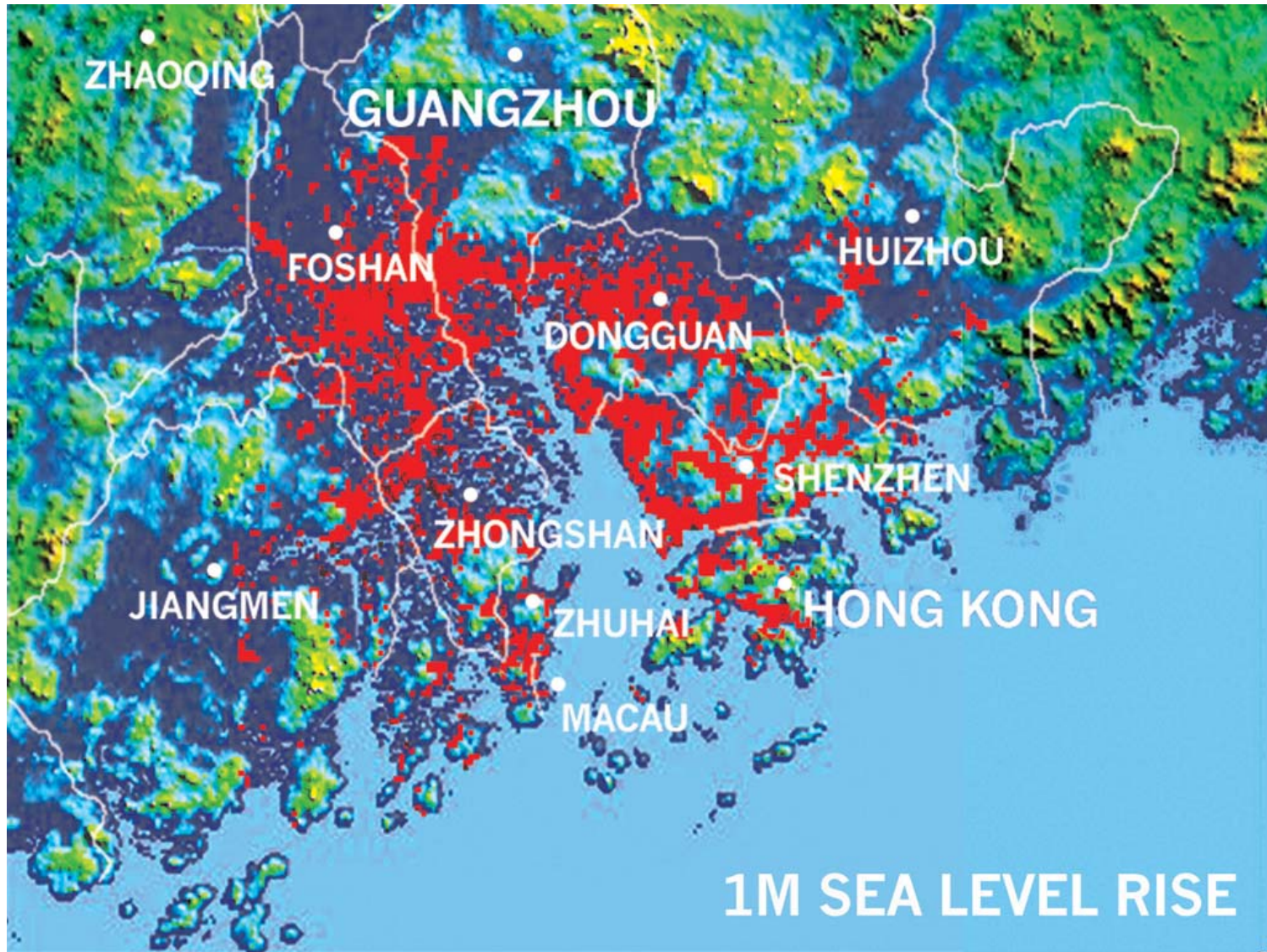
What about climate change?

For full report, see
www.civic-exchange.org

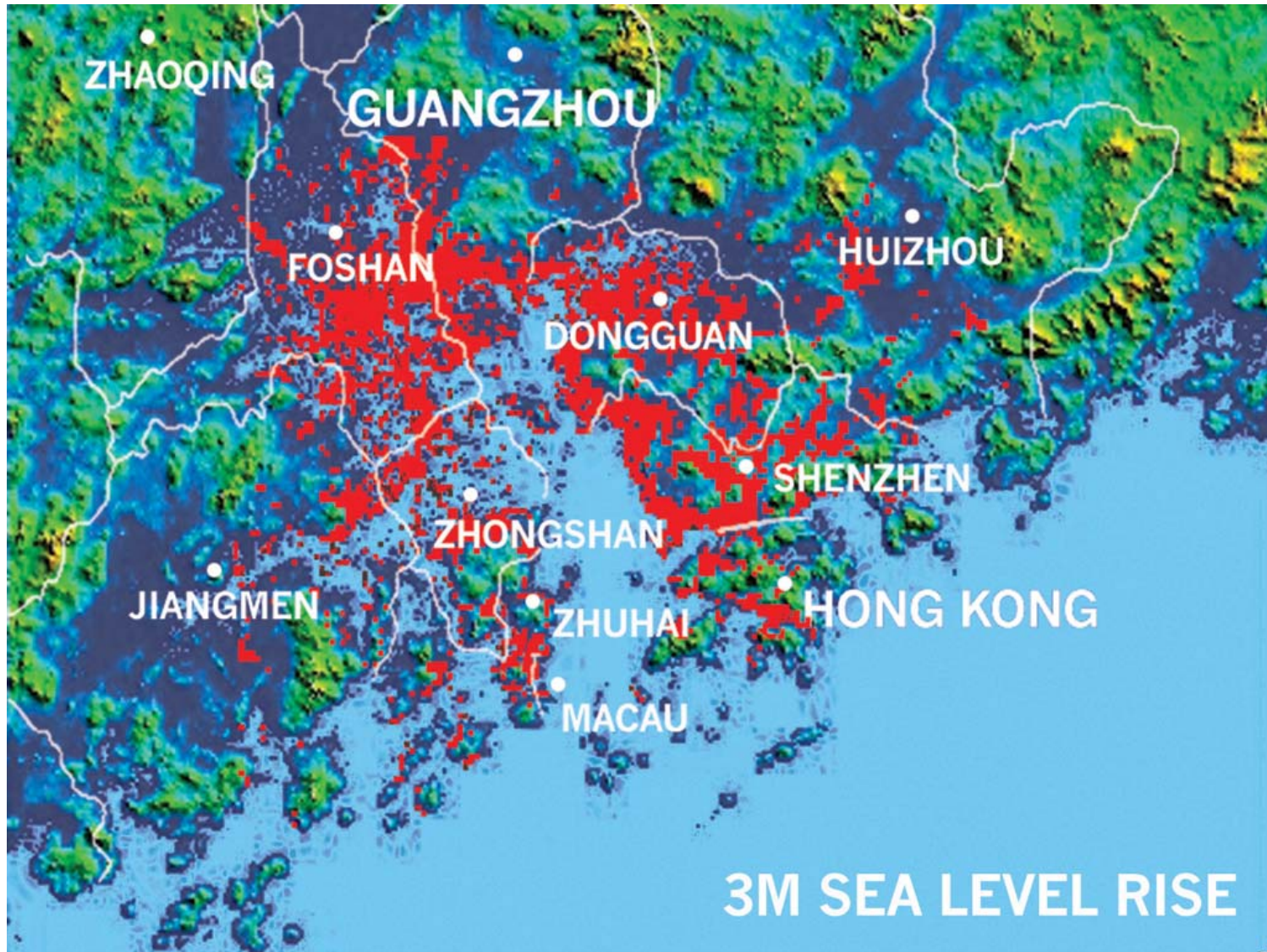
Impact of Climate Change: Rising Sea Levels



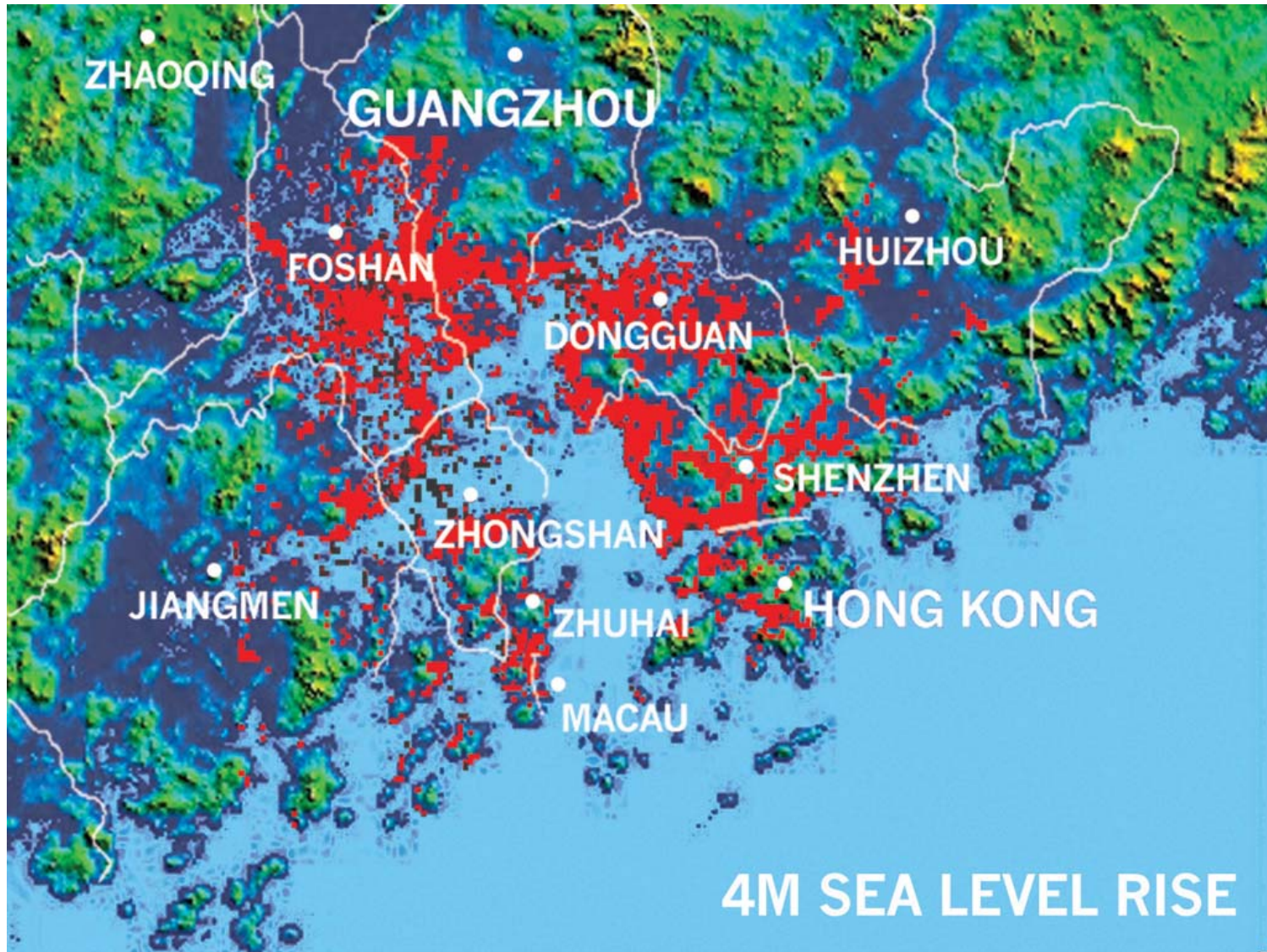
Rising Sea Levels



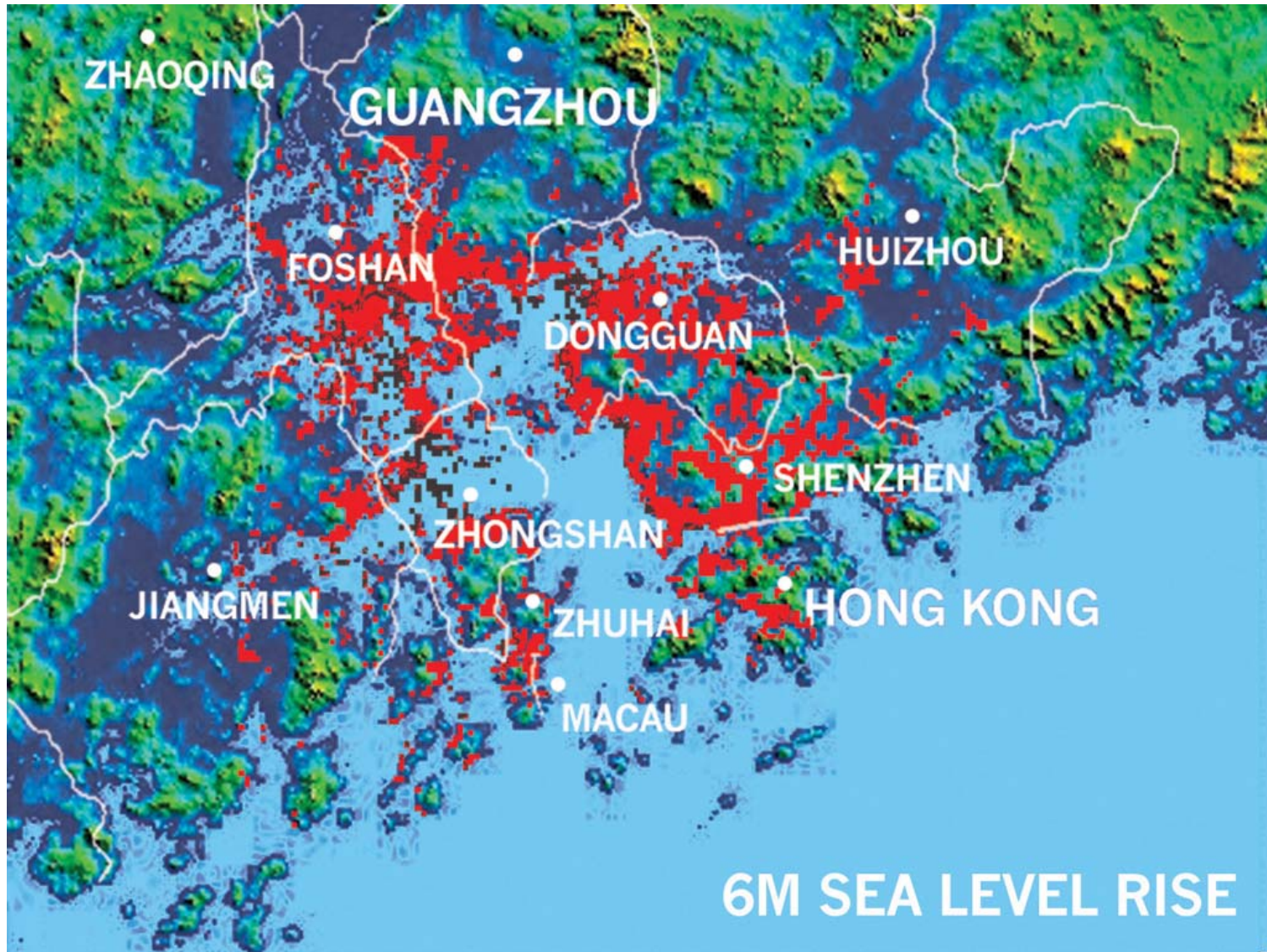
Rising Sea Levels



Rising Sea Levels



Rising Sea Levels




Erratic Rainfall






Qingyuan

Heyuan

 Huadu Airport

Huadu

Zengcheng

 Huizhou Airport

Zhaoqing River Port

Shati Airport

Guangzhou



Huangpu



Nanhai

Dongguan

Huizhou

Foshan

Panyu



Humen Port

Hulyang

Gaoming River Port



Rongqi River Port






Humen Port

Huangtian Port



Huangtian Airport




 Aotou Port

Jiangmen River Port



Nansha



 Yantian Port

Xinhui River Port



Nansha



Shenzhen

Zhongshan Port
Ma Wan &
Chi Wan Ports





Hong Kong

Kaiping

Zhongshan Port

Ma Wan &
Chi Wan Ports





Hong Kong

Shekou Port



 Kwai Chung
Container Port

Taishan

Doumen River Port





Hong Kong
International
Airport



Ka Ho Port





Jiuzhou
Port



Macau
Airport



Zhuhai (Gaolan) Port



Zhuhai Sanzao
Airport



-  R RIVER
-  O OCEAN
-  AIRPORT
-  EXPRESSWAY